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Emission Testing and Evaluation of Ford/Koppers Coke Pushing Control System. Volume I. Final Report

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EMISSION TESTING AND EVALUATION OF FORD/KOPPERS COKE PUSHING CONTROL SYSTEM; VOLUME I. FINAL REPORT



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16. ABSTRACT The report documents a field testing and engineering evaluation of the performance of a retrofitted, mobile-hood, high-energy-scrubber control system, abating coke-side pushing emissions from a 58-oven coke battery. It documents the venturi-scrubber inlet and outlet emission rates, as well as emission factors for filterable and condensible particulate, sulfur dioxide, sulfur trioxide, total sulfur oxides, carbon monoxide, nitrogen oxides, benzene, benzene and homologues, total light hydrocarbons, methane and homologues, and ethylene and homologues. Results indicate that the mobile hood collects particulate emissions resulting from green and clean pushes at 22% to 54% efficiencies, respectively, or from 30% to 92%, respectively, using two different estimating techniques. Scrubber performance averaged 99.3% for particulate emissions captured in the hood.

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by

Fred Cooper, Thomas Loch,
John Mutchler, and Janet Vecchio
(Clayton Environmental Consultants, Inc.)

Ford Motor Company
The American Road
Dearborn, Michigan 48121

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EPA Project Officer: Norman Plaks

Industrial Environmental Research Laboratory
Office of Energy, Minerals, and Industry
Research Triangle Park, N.C. 27711

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GLOSSARY OF TERMS

1. Coke-Pushing Emissions

   An intermittent source emission lasting about 40 to 60 seconds, occurring on an irregular cycle with an average interval of 15 to 16 minutes.

2. Emission Factor

   A ratio of rate of emission of some chemical species to the production rate associated with the process causing the emission.

3. Coke Side of Battery

   That side of a coke oven battery from which the ovens are emptied of coke.

4. Push Side of Battery

   That side of a coke oven battery into which the pusher ram is inserted to empty the oven of coke.

5. Gross Coking Time

   The elapsed time in minutes between two successive pushes of the same oven.

6. Net Coking Time

   The elapsed time in minutes between the charging of a coke oven with coal and the pushing of that same oven.

7. Door Leakage

   Any visible emissions observed emanating from coke-side oven doors, push-side oven doors, or push-side chuck doors.

8. Quench Car Movement Emissions

   An intermittent source emission lasting about 15-40 seconds, from the end of a coke oven push to commencement of coke quenching.

9. Degree of Greenness of a Coke Oven Push

   The subjective, visual estimate of the particulate matter released during a single coke oven push.

10. Clean Push

    A source emission on the coke side which is resultant from the pushing of an oven whose charge has been carburized

completely enough so as to produce only slight quantities of visible particulate throughout the push duration.

11. Green Push

A source emission on the coke side which is resultant from the pushing of an oven whose charge has been carburized incompletely enough (throughout its entire mass) so as to produce copious quantities of visible particulate and/or flame throughout the push duration.

12. Fugitive Particulate Emissions

Particulate emissions which escape capture from the hood and pass unrestrained into the atmosphere.

13. Total Pushing Emissions

The sum of the inlet of the control system particulate emission captured and entering the control system and the fugitive particulate emission.

14. Filterable Particulate

Material captured at a specified temperature, pressure, and chemical activity, on or before the first filter in a particulate sampling train.

15. Total Particulate

Material captured at a specified temperature, pressure, and chemical activity, including condensibles, in an entire particulate sampling train.

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1.0 SUMMARY AND CONCLUSIONS

In 1970, Ford Motor Company contracted with the Koppers Company to design and construct an emission control system to abate coke-pushing emissions at its Dearborn, Michigan steel-making operations. In 1973, the United States Environmental Protection Agency (EPA) contracted with Ford Motor Company to evaluate and document the performance, reliability, and operating costs of the installed Koppers system as it represents an important contribution to the developing state-of-the-art in coke-pushing emission control technology.

Thereafter, Ford Motor Company engaged Clayton Environmental Consultants, Inc., as subcontractor, to perform required measurements, observations, and analyses necessary to provide a quantitative and objective evaluation of the Koppers system with regard to performance efficiencies, reliability, operability, and maintainability. This report summarizes that evaluation, and provides a record of system performance based upon these measurements and the long-term observation of day-to-day operating characteristics. In addition, the Koppers Company was subcontracted to write a system design manual entitled "Coke Oven Smokeless Pushing System Design Manual," September, 1974. This manual is available as a published document from the Office of Research and Development, U.S. Environmental Protection Agency. The Environmental Protection Technology Series number is EPA-650/2-74-076.

1.1 Overall Evaluation of the System

The results of this study, obtained by sampling and analysis, still photography, and extensive visual observation, indicate that a 41- to 66-percent reduction in filterable particulate emissions and a 20- to 33-percent reduction in condensible emissions can be realized from coke pushing at the Ford coke battery when using the Koppers system to control a variety of pushes ranging from "clean" to "green." These reported ranges in efficiency are based upon average degree-of-greenness ratings obtained during multi-push particulate tests (i.e., 16 or 24 pushes per test). Because average degree-of-greenness for the multi-push particulate sampling tests included in the study was never less than 1.4 nor greater than 2.4 (on a scale of one to three for "clean" and "green" pushes, respectively), the reported ranges may not reflect system performance for "very clean" or "very green" pushes. While multi-push particulate tests cannot, therefore, indicate performance for a single push, indirect estimates based on statistical analyses of available data, indicate that hood capture efficiencies may range from 30 percent (green push) to 92 percent (clean push) using visual estimating techniques and from 22 percent (green push) to 54 percent (clean push) using hi-volume air sampling techniques to estimate the extent of fugitive emissions. Of the push particulate emissions

captured in the control system hood, 99.3 percent, on the average, are removed by the scrubber. Because the reported range in control system performance is dependent on push greenness, overall performance can be extrapolated to another similarly configured coke battery only to the extent that the sequence and nature of push-plumes sampled in this program are typical of another coke battery's operation.

The estimated range in hood capture efficiency at a given degree-of-greenness derived from the two techniques (22 to 30 percent for green pushes and 54 to 92 percent for clean pushes) represents only an estimate of actual fugitive emissions. These estimates of fugitive emissions form a multiplicative factor for converting measured emissions in the scrubber inlet duct where sampling was conducted to total pushing emissions. This factor is therefore contained implicitly in all emission factors. Thus, the evaluation of hood capture efficiency, and therefore, of total system abatement efficiency, is completely dependent upon the accuracy and precision of the methods for estimating fugitive emissions. Moreover, all expressions of emission factors must be qualified by the limitations of the sampling technique and used cautiously in attempting to predict emissions expected from similar batteries.

The measured collection efficiency of the scrubber for filterable particulate from the push emissions actually captured by the movable hood ranges from 99.1 to 99.6, and averages 99.3 percent. Scrubber collection efficiency in abating condensibles ranges from zero to 90.5 percent, and averages 47.7 percent. The scrubber outlet plume opacity ranges from nil for "clean" or "moderately green" pushes to about 40 percent or greater for "green" pushes. In light of the relatively high scrubber efficiencies, the exit gas opacity is directly attributable to the very high inlet particulate loadings that are characteristic of green pushes.

The ability of the system to function well in an environment realistically typical of coke batteries is an important issue, and this evaluation provides a representative context in which to appraise the system. The inevitability of green pushes in any coke battery requires that a coke-pushing control system be able to maintain collectability and extractability to a degree that will conform with reasonable regulations. The information and data gathered in this study indicate that the system does not capture emissions in an efficient manner for moderately green or green pushes. However, of the emissions captured during a push, the scrubbing efficiency for filterable particulate is excellent.

In addition to particulate matter, emission source testing was conducted for 31 different chemical compounds. Of these, most were found below the limits of detectability for the sampling and analytical procedures used on the airstream entering

the scrubber, where concentrations would be expected to be the greatest. Of those materials detected, the following contaminants have been considered in evaluating the ability of the control system to both capture and remove them: sulfur dioxide, sulfur trioxide, total sulfur oxides, carbon monoxide, nitrogen oxides, benzene and homologues, total light hydrocarbons, methane and homologues, and ethylene and homologues. For many of these materials, total system abatement efficiency varies widely. This is largely attributable to emission measurements performed in exhaust airstreams containing very low concentrations of these contaminants. Generally, average overall system efficiencies, including estimated hood capture, range from nil to 60 percent for these materials. Replicate tests were conducted for each contaminant, some of which were multi-push samples including a variety of push types ranging from "clean" to "green."

Maintenance records and on-site system observations indicate that the emission control system is prone to 20-percent downtime which results especially during periods when a chronic failure occurs that is difficult to diagnose. Based upon system observation, the redesign of several system components would likely reduce downtime significantly.

The costs associated with maintenance, including manpower and replacement parts, show no obvious trend to increase as the system ages. Examination of maintenance and cost accounting records that document system maintenance shows that average maintenance costs amount to about $0.15 per ton of coke produced on the 58-oven battery.

The utility requirements can vary widely, depending upon system operation. By design, the system operates in an idle mode between pushes, depending upon operator discretion. Once the coke guide operator establishes alignment with the next oven to be pushed and activates the system, fully operational-mode status is reached, requiring about 2000 HP of fan power. Depending upon scheduling and the number of pusher machines and quench cars available to a particular battery in a multi-battery facility, the utility costs may vary substantially. Based upon prolonged observation at the Ford Motor coking facility, electrical energy requirements average about 30 KW-HR per ton of coke produced on the 58-oven battery.

In summary, the system, in its current configuration, abated pushing emissions during the test program with an efficiency estimated to range from 41 to 66 percent for filterable particulate, the prime contaminant. Nevertheless, the control system eliminated only about one-half of normal-operation emissions produced by coke pushing at the time of the study.

Although the system was not operated in accordance with its original design during the testing and evaluation program, we view these results as both realistic and representative.

Undoubtedly, the harsh environment and occurrence of green pushes, somewhat characteristic of even a new coke battery, are responsible for many of the system modifications that have resulted in performance somewhat less than that asserted in the Koppers Design Manual. In our opinion, the mobile hood, as designed, would not efficiently capture pushing emissions resultant from a moderately green or green push. We believe that capture efficiency can be improved measurably, however, if the hood dimensions and exhaust volume rate are increased substantially.

1.2 Emission Factors

All emission factor estimates contained herein that characterize total push emissions are necessarily based upon and limited by the technique used to estimate fugitive emissions. The degree to which the fugitive emission estimate is biased directly affects the level and precision of the estimated emission factor.

Using the data and statistical analysis conducted in this study, coke-pushing emission factors have been computed which characterize the Ford battery under study. Although these emission factors are expected to be representative of a facility manufacturing blast furnace coke and experiencing a moderate frequency of green pushes, variation in actual emissions can be expected among coke batteries due to variation in coke oven maintenance, type of coal charged, net coking time, coking temperatures, meteorological conditions, and battery geometries.

Emission factors are presented in both metric and English dimensional units. In other sections of this report, English units are used because, in the U.S., common practice in the coke production industry incorporates this system of units.

Using a scale that associates a greenness rating of "1.0" with a "clean" push and "3.0" with a "green" push, a series of multi-push particulate tests, whose average greenness ratings range from 1.4 to 2.4 and average 1.8, have been used to calculate the following emission factor estimates. Pushing emissions, expressed as "kilograms per metric ton of wet coal charged," and parenthetically as "pounds per ton of wet coal charged," and derived using two different methods of estimating fugitive emissions, range from 0.60 to 1.9 (1.2 to 3.8), and average about 1.2 (2.3) for filterable particulate; similarly, emission factors range from about 0.006 to 0.07 (0.012 to 0.14) and average about 0.033 (0.067) for condensibles. Of these total pushing emissions, filterable fugitive emissions are estimated to range from 0.13 to 1.3 (0.25 to 2.5), and average 0.60 (1.2); similarly, the fugitive emissions of condensibles, based on the two measurement techniques, are estimated to range from 0.001 to 0.05 (0.002

to 0.10), with an average of about 0.018 (0.035). Of those pushing emissions captured at the collection hood, the inlet emissions to the scrubber, expressed as "kilograms per metric ton of wet coal charged," and parenthetically as "pounds per ton of wet coal charged," range from 0.48 to 0.65 (0.95 to 1.3) with an average of 0.55 (1.1) for filterable particulate; inlet emissions of condensibles measured in the inlet duct range from 0.0047 to 0.023 (0.0093 to 0.046) with an average of 0.016 (0.032). For the control efficiencies measured, the scrubber outlet emissions of filterable particulate range from 0.0023 to 0.005 (0.0045 to 0.010) and average 0.0039 (0.0078). Condensible emissions from the scrubber outlet range from 0.0021 to 0.017 (0.0041 to 0.033) and average 0.008 (0.015).

The aforementioned emission factors are based upon metric tons of wet coal charged. Table 1.2 provides the necessary conversion factors to enable computation of emission factors in terms of dry coal charged or in terms of coke produced.

As indicated, the particulate emissions, whether fugitive from the hood collection area or emitted from the scrubber outlet stack, when compared with the computed pushing emissions, translate to total system abatement efficiencies which average from about 40 percent to 65 percent. Conversely, about 35 to 60 percent of particulate pushing emissions are uncontrolled, based upon the tests conducted in this study, including the technique for estimating fugitive emissions.

Emission factors are also developed in this report for certain gaseous contaminants. These emission factors are likewise based upon, and limited by, the methods used to estimate fugitive emissions. The extent to which estimates of hood capture efficiency are subject to error affects directly the accuracy of the emission factors developed for gaseous constituents (see Section 5.2.3). In general, the estimated emission factors for gaseous components are low when compared to the particulate emissions. Particulate apparently constitutes more than 80 percent of all the pushing emissions.

None of the emission factor estimates presented include door leaks which, by design, are not controlled by the "Koppers Smokeless Coke Pushing System." In that sense, the results of this study cannot be compared directly with other coke oven emission studies which include observations and measurements on total coke-side emissions.

2.0 INTRODUCTION

The passage and amendment of the Clean Air Act and the continuing promulgation of emission regulations by federal, state, and local agencies lead toward specificity in emission restrictions and control measures for major stationary sources. In an attempt to minimize the economic impact of regulatory compliance, the U.S. Environmental Protection Agency has commissioned a host of studies which attempt, as their end purpose, to document the best practical control technology applicable to specific major emission sources in various industries.

In the iron and steel industry, metallurgical coke is used as the primary fuel and reducing agent in the smelting of iron ore in a blast furnace. In an integrated steel-making complex, the production of coke has been a major source of fugitive emissions which detract from the quality of the ambient air.

In a step-wise approach to bring steel plants into compliance with air quality regulations, the U.S. Environmental Protection Agency has undertaken several studies to define the state-of-the-art of emissions control from coke production operations, including that of "coke pushing." To abate coke-pushing emissions, which include visible particulate, hydrocarbons, carbon monoxide, and a wide variety of organic compounds resulting from incompletely carburized coke, several types of basic emission control strategies are available. One such design uses a traveling hood which captures and conducts coke-pushing emissions into ductwork leading to a high-energy venturi scrubber. Long-term performance, capture of pushing emissions, and scrubbing efficiency of captured emissions using such a device is the subject of this study. This report summarizes a comprehensive evaluation of the Koppers coke pushing emissions abatement system at the Rouge Plant Coke Battery of Ford Motor Company in Dearborn, Michigan.

2.1 Background and Purpose

According to a recent study designed to determine the cost impact of environmental control regulations on the integrated iron and steel industry, coke production peaked at approximately 61.5 million tons in 1974.(1) According to the EPA compilation of air pollution "emission factors," about one pound of particulate and gaseous pollutants is emitted per ton of coke during the pushing operation.(2) Therefore, about 60 million pounds of gases and particulate matter are discharged to the atmosphere annually from the pushing operations at coke batteries. It is the general consensus that the pushing operation represents the second largest source of emissions in coke oven operations; uncontrolled charging operations represent the largest single source.

Clearly, the efficient abatement of coke-pushing emissions would eliminate some 30,000 tons of atmospheric particulate and gaseous contaminants annually if a practical control method could be demonstrated and then applied. The purpose of this study is to evaluate the efficiency and viability of such an existing control system. This report, in conjunction with similar reports which evaluate other control strategies designed to abate coke-pushing emissions, constitutes a data base upon which regulations designed to limit emissions from coke batteries can be developed.

The Steel Division of Ford Motor Company, Dearborn, Michigan is under contract with the U.S. Environmental Protection Agency to evaluate the Koppers control system for the abatement of coke-pushing emissions (EPA Contract No. 68-02-0630). As a subcontractor to Ford, Clayton Environmental Consultants, Inc. furnished services for the emissions testing and system evaluation. In addition to Clayton's work, the system designer and manufacturer, the Koppers Company, wrote a "Coke Oven Smokeless Pushing System Design Manual" available as a published document from the U.S. Environmental Protection Agency.

2.2 Project Objectives

The overall objective of this project was to evaluate the Koppers coke-pushing control system with reference to control efficiency, reliability, and cost. The scope of the evaluation included acquisition of historical performance and cost data, determination of the nature and extent of contaminant species present before and after the abatement controls, and compilation of daily records of coke production and system performance, which include documentation of causes and costs associated with system downtime. To provide such an evaluation, the system study was designed to achieve the following objectives.

1. The primary objective was to evaluate the control system's effectiveness for controlling coke-pushing emissions by documenting — subjectively and objectively — the control system's efficiency of abatement for various contaminant species that are characteristic of the pushing operation. To accomplish the evaluation meaningfully, it was essential to not only quantify scrubbing efficiency, but also measure hood capture efficiency.

2. A secondary objective was to maintain records of coking time and production rates as they relate to the evaluation of system performance and emission factors.

3. Another objective was to maintain records of the system's operability through long-term observation with regard to system maintenance and percentage of pushes for which the control system functions efficiently.

4. An additional objective was to determine the costs associated with operation and maintenance of the control system.

5. A final objective was to extrapolate the system's applicability to new or existing coke oven batteries in other locations.

Because the available literature characterizing pushing emissions is inadequate, it was necessary during this project to determine what contaminant species are present to a measurable degree at the inlet to the control system at the Ford plant. By documenting the presence of certain contaminant species, together with characteristic concentrations, a more credible roster of contaminants emitted from coke pushing is now available.

In an effort to execute this project and present the results in an orderly manner, the project was divided into the following tasks.

2.2.1 Documentation of Historical Performance

The objective of this task was to procure the historical data which document the operability and maintenance requirements of the coke-pushing emission control system. Such information is useful in defining many of the system malfunctions. Further, documenting trends in the historical downtime record would reveal any tendency of the system to degrade with age or use.

2.2.2 Documentation of Historical Economics

The objective of this task was to procure cost data related to the operation and maintenance of the control system. The Ford Motor Company accounts document the funds expended with respect to maintenance man-hours and replacement parts. Analysis of this cost data is useful in determining any tendencies toward increased expenditure with time to maintain efficient operation of the control system. Further, such data, when normalized to coke production rates, are used in defining expected operating costs when applying this system to coke batteries in other locations.

2.2.3 Determination of System Operability

The objective of this task was to update the recorded performance data of the control system by on-site system observation. The on-site engineer-observer recorded all required process data throughout the course of any source test conducted at the inlet and outlet of the control system.

Pertinent process parameters include coal charge records, the number and quality of pushes, the coking time, the general efficiency of operation of the control system as it can be determined by visual observations, equipment malfunctions, and necessary corrective measures.

2.2.4 Measurement of Scrubber Performance

The objective of this task was to provide a complete inventory of the emissions resulting from coke pushing and the scrubbing efficiency for each contaminant. Fulfilling the objective requires development and testing of acceptable sampling and analytical procedures for each contaminant.

Those parameters which are required to correlate scrubber efficiency to process conditions include: static pressures measured at inlet and outlet of the scrubber throat, the scrubber outlet, the mist eliminator outlet, and the fan inlet to determine the contact power transmitted to the gas stream; temperatures measured in the inlet scrubber water, the inlet gas stream, and the outlet gas stream to determine vapor-liquid equilibria applicable to the scrubbing of gaseous contaminants; psychrometric calculations to determine total water requirements; and measured flowrates of the exhaust gas and scrubbing water to determine gas-to-liquid ratios for scrubber contact power correlations.

2.2.5 Evaluation of the System and Its Applicability

The objective of this task was to assemble an evaluation which can be used by regulatory officials and other coke plant personnel to assess the applicability, efficiency, and cost of the mobile hood coke-pushing system. The degree of emissions abatement from the pushing operations and the reliability of the system over a prolonged period are criteria used in the evaluation.

3.0 COKE PRODUCTION IN THE IRON AND STEEL INDUSTRY AND AT FORD MOTOR COMPANY

Coking is a process by which coal is destructively distilled in an atmosphere of low oxygen content to produce volatile gases and a residue of relatively non-volatile coke. Of the two processes available for the manufacture of coke, the "by-product process" accounts for more than 90 percent of the coke produced; the beehive process accounts for the remainder. In the by-product process, gases are recovered as they are produced during the coking cycle.

A contiguous series of coke ovens, separated by heating flues placed between ovens, constitutes a "battery" of ovens. A typical by-product coke oven is rectangular, 30 to 40 feet long, from six to 14 feet or more in height, and 11 to 22 inches wide.[3] In a modern coke battery, from 16 to 30 tons of coal are charged to each oven. Subsequently, the ports are closed and the temperature in the ovens is maintained at 2000 to 2100°F for 16 to 20 hours. Coking begins at the oven walls and proceeds toward the center of the charge. At the end of the coking cycle, a ram operating from the "push" side of the oven forces the coke through the oven and out the "coke" side of the oven where the incandescent coke passes through a temporarily-aligned coke guide and falls into a quench car. In the United States, coke is usually cooled in a quench tower using water sprays. Water flows over the incandescent coke for about one minute, after which the coke is conveyed to a screening location.

If the coking of a given oven charge is complete, most of the volatile constituents distilled from the coal charge will have been removed and piped to adjacent chemical plants where usable products are subsequently extracted. The combustible portion of the coke oven gas is usually recycled to the coke battery to supply requisite heat.

The two major sources of emissions from the coking operation are the charging and pushing cycles. With recent innovations, charging emissions are controllable to a significant degree. The development of practical control technology to abate pushing emissions is the subject of many recent investigations. The following process description and delineation of process emissions provide an overview of the pushing operation as it relates to the investigation summarized in this report.

3.1 Description of the Pushing Process

3.1.1 General Description

After 16 to 20 hours, the coke must be removed from the ovens and quenched. To remove and collect the coke, traveling pusher cars and coke guides serve an

entire battery of ovens. Several minutes before a push is scheduled, door machines on the push and coke sides of the oven loosen and remove the doors which span the entire height and width of the oven. After the pusher and coke guide have been aligned, coke is removed from the oven by a mechanical ram. The coke travels through the coke guide and falls into the quench car which is positioned on the coke side of the oven being pushed.

It is necessary for the quench car to move slowly beneath the coke guide to permit even and uniform distribution of the coke loaded in the quench car. When the oven is completely empty, the pusher ram withdraws and the quench car moves to the quench station, usually located at the end of the coke oven battery.

After bench cleanup, both the push-side and coke-side door machines replace the oven doors in preparation for coal charging by the top-side larry car. The cycle is then repeated with the oven not being pushed again for 16 to 20 hours.

3.1.2 Pushing Process at Ford Motor Company

Four coke oven batteries produce coke suitable for blast furnace use at the Ford Motor Company Steel Division, Dearborn, Michigan. "A" Battery at Ford is outfitted with the subject pushing emission control device. The "AX" Battery, an extension of "A" Battery, is also serviced by the control system. The 10-year-old "A" Battery consists of 45 ovens each 13 feet high. Each oven produces, nominally, 12 tons of blast furnace coke with gross coking time of 18 hours. A "push" is scheduled about every 15 minutes. The "AX" Battery consists of an additional 13 ovens which are 13 feet high with each oven capable of producing 12 tons of blast furnace coke.

One larry car, one pusher car, and one coke guide serve the 58 ovens in "A" and "AX" Batteries. The quench car serving "A" and "AX" Batteries serves "B" Battery as well.

In the typical sequence of operations observed, the door machine on the pusher car removes the door of the oven to be pushed. The pusher car then performs the leveling operations for an oven which has just been charged by the overhead larry car. The leveling operation takes from two to five minutes to complete. The pusher car then returns to the oven scheduled for pushing whose door has been removed. During this sequence of operations, the coke-side door machine

removes the door on the coke side and positions the coke guide for the oven scheduled to be pushed. Both machines then await the arrival of the quench car which, as previously mentioned, is shared among "A," "AX," and "B" Batteries. In this sequence of operations, doors remain off on both the push and coke side for time intervals which range from two to 15 minutes, exact times depending on the production schedules and the service needs of the two batteries. If the operations on either "A" or "B" Battery are behind schedule due to any of a variety of reasons, from 15 to 45 minutes may elapse before the quench car arrives to receive the coke from the oven to be pushed.

In this study, pushing emissions are defined as emissions leaving the open coke-side door during the 1-minute time interval that begins when the pusher ram enters the oven. All coke pushes observed on "A" and "AX" Batteries at Ford required from 30 to 45 seconds to load the quench car. Approximately one minute is required from the beginning of the coke-push cycle for the emission control system to capture the emissions thus produced. After the push, the quench car travels from the oven just pushed to the quench station located at the south end of "A" Battery.

Oven No. 1 is nearest the quench station, and Oven No. 64 on "AX" Battery is the farthest. (Oven numbers ending with zero are not included in the oven numbering scheme for the 58 ovens.) Travel distances to the quench station for the quench car range from about 50 feet to the nearest oven to approximately 250 feet to the farthest oven.

3.2 Pushing Emissions

When coke is pushed from a coke oven, relatively fine particulate is emitted due to convective currents which entrain the loose dust. Coarser, abraded coke is also produced as the hot coke falls into the quench car. Incompletely coked material results in emissions of particulate and volatile constituents. Most of the incompletely coked material usually resides near the ends (that is, adjacent to the coke-side and push-side doors) where heat losses are the greatest. When the oven doors are removed, some of the volatile constituents of partially-coked material are dispersed to the ambient atmosphere. Depending upon the extent to which the end material is uncoked, emissions can include any and all of the by-products produced upon destructive distillation of the coal throughout the entire coking cycle. Reportedly, the emissions resulting from uncoked material can include ammonia, coke oven gas, tar, phenol, light oil,

benzene, toluene, xylene, pyridine as well as coal tar pitch volatiles and some carcinogenic materials such as benzo(a)-pyrene.(4) More commonly, emissions from partially-coked materials are comprised predominantly of visible particulate, light hydrocarbons, carbon monoxide, and some coal tar pitch volatiles.

During pushing, the majority of the emissions which escape into the ambient air from uncontrolled sources consist of particulate matter.(4) These emissions may originate from incompletely carburized coal that is adjacent to the cool oven doors on the ends of the oven and may, therefore, be more copious at the beginning and end of a push. In those ovens where insufficient temperatures are maintained during the coking cycle, the center of the oven charge may also contain incompletely carburized coal which contributes to elevated emissions throughout the push.

As the push is occurring, the quench car necessarily moves to distribute the coke along its entire length. During this time fugitive emissions emanate from the coke over the length of the quench car to a degree which is dependent upon the degree of carburization. So-called "green" pushes emit particulate matter and volatile constituents throughout the entire push cycle. As the quench car then travels to the quench station, these emissions continue to evolve until the coke is cooled below incandescence. During the quench cycle for such green pushes, the resultant emissions are entrained in the steam produced and pass out the top of the quench tower.

After the doors are replaced and coal is charged by the overhead larry car, the newly-introduced coal emits considerable amounts of volatile constituents as it encounters the heated oven walls. Generally, depending upon the degree of door maintenance, this is the time period in which the largest amounts of "door leaks" occur as the volume of volatile constituents generated cannot be handled by the by-product collection devices. These door leaks are at their peak at charge time and gradually decrease as the coking time increases. Control of door leaks while the doors are in place is largely a function of the degree of maintenance practiced. Additionally, emissions occurring on the push side during leveling can be responsible for considerable emissions since they occur at the time when the coal charge is emitting the largest amount of volatiles.

Typical emissions for coke oven batteries, as they are documented in the Compilation of Air Pollution Emission Factors,(2) include particulate, carbon monoxide, hydrocarbons, and ammonia. These emissions have been documented to occur during the coking cycle (as door leaks) and during the pushing cycle. Emission factors for each of these species are displayed in Table 3.2-1. As indicated, depending upon the degree of

carburization, other volatile constituents may be emitted. Table 3.2-2 summarizes those constituents which comprise the contaminants roster investigated in this study. Many of these materials were included as potential process emissions since they are present in coke oven gas obtained from by-product recovery. Experience and the literature indicate potential emissions, then, of: nitrogen oxides, sulfur oxides, hydrogen sulfide, carbon monoxide, methane and its homologues, ethylene and its homologues, acetylene, total light hydrocarbons, total reduced sulfur, benzene and its homologues, pyridine, carbon disulfide, coal tar pitch volatiles, naphthalene, acrolein, phenol, hydrogen cyanide, chlorine, and ammonia, as well as particulate matter consisting of carbonaceous materials, condensible oils, and various metallic compounds.

4.0 DESCRIPTION OF THE FORD/KOPPERS COKE-PUSHING EMISSION CONTROL SYSTEM

This section describes the design, operating parameters, and operating characteristics of the emission control system, manufactured by Koppers Company, designed to abate coke-pushing emissions. While the specific parameters which will be listed pertain to the Ford Motor Company, Rouge Plant Coke Operation, sufficient data are provided to allow some extrapolation of the design and operating parameters associated with application of this system to coke oven batteries in other plants.

4.1 System Design

In fulfillment of this contract, Koppers Company wrote a design manual for its control system as installed at Ford. This manual documents the total system as it was designed — coke oven pushing emission control capability, operability, reliability, and maintainability. The complete manual is available from the U.S. Environmental Protection Agency. Salient features are delineated here to provide an overview of those portions of the basic control system design that were observed to affect materially the operability or maintainability of the system.

The conventional coke guide and door machine is modified in this system to accommodate those appurtenances necessary to convey coke emissions into a collection hood. The hood is an integral part of the coke guide. By providing sufficient suction via an induced draft fan upstream and by reducing clearances between the hood perimeter and the quench car, relatively high indraft design velocities can be maintained.

Prior to a push, the coke guide is aligned with the oven in a conventional manner and the motorized "Rayco" cylinder moves an extendible arm located at the top of the hood. This arm opens a set of double doors on an overhead exhaust duct which is connected to the induced draft fan. As the extendible arm moves out and contacts two protruding levers, the doors open into the duct leading from atop the hood snorkle. After reaching its full extension, a limit switch is tripped to initiate louver movement upstream of the draft fan, thus providing full suction to the exhaust hood. This circuitry is necessary to prevent full suction while the doors are being opened. The extendible arm would be incapable of opening the exhaust duct doors against such high negative pressures.

The coke, as it is pushed from the oven, falls into the quench car whose open top is partially covered by the exhaust hood. As the quench car slowly moves to provide a leveled load of hot coke, emissions from the car are drawn into the hood and pass through the ductwork leading to the scrubber.

Captured emissions are conveyed through the exhaust ductwork and enter the high-energy Kinpactor® scrubber. The wet scrubber is equipped with a recirculated water supply system. After being scrubbed, the exhaust gases and entrained moisture are forced to make a right angle turn. Larger drops of moisture impinge on the bottom of the elbow and provide a wetted surface which minimizes abrasive wear. The gases then enter a cyclonic-type mist eliminator. The water collected in this mist eliminator is returned to the water recirculation system. The gases pass out of the mist eliminator and into an induced draft fan which exhausts to a stack.

During observation of the control system by the engineeer-observer from Clayton Environmental Consultants, Inc., certain operational characteristics of the system were noted which differ from the system design as it is documented in the design manual. These are described here so that the system may be properly characterized when attempting to relate system performance to system design. Some of these changes are further documented in the Koppers design manual that delineates "Post Start-up Modifications."

Due to the modifications, it was not possible to evaluate the control system strictly according to original design. Nevertheless, because these post-start-up modifications were performed out of necessity to provide a functional control system within the harsh environment characteristic of coke pushing, we believe the evaluation set forth in this study represents the Koppers control system as it would exist and perform on other coke facilities.

4.2 System Modifications and Observed Operation

In the original design, the collector hood was fitted with movable seal plates designed to move into place and fit over the contour of the quench car. Each seal plate was raised and lowered by an electrically actuated cylinder. In the "up" position, normally seven inches of clearance exists between the quench car and the locomotive. In the "down" position, approximately two inches of clearance exists. As indicated in the design manual, the operator did not always use these seal plates during each push. After one year, the plates were never used. Therefore, the original plates were removed and fixed plates were installed allowing sufficient clearance for the quench car and the locomotive to pass. While this afforded some improvement by providing closer clearances between the hood and the quench car, air infiltration velocities in the clearances were somewhat less than in the original design. In addition, it was necessary to remove the baffle plates from the quench car and to cut back the end plates of the quench car which further reduced infiltration velocity, a crucial parameter that governs the efficiency of emission capture around the hood perimeter.

As noted in the design manual, the synchronization unit allows the operator to provide a level load of coke in the quench car without seeing the coke in the quench car (due to the built-up ends designed to maximize indraft velocity). However, critical alignment problems coupled with airborne dust resulted in the rapid deterioration of the synchronization unit. After several attempts to repair the unit, the synchronization unit failed to perform adequately. As a result, it was necessary to remove enough of the end plates on the operator's side of the quench car to permit visual leveling of the coke.

The design manual describes a motorized cylinder that extends the telescoping section of the hood snorkel to connect to the exhaust duct. The control system was provided with a butterfly damper designed to open and relieve suction in the exhaust duct so that the doors (which are accessed by the hood snorkel) would be easier to open. Koppers Company conducted a test in 1973 to determine the extent of air inleakage, and therefore of negative pressure in the exhaust duct, when the butterfly damper was not used. Apparently, sufficient leakage existed around the multitude of doors in the duct to relieve the suction and assure that the electric cylinders could open the doors even with the butterfly damper closed. Since these tests indicated that the butterfly damper was not required, it was welded shut. In other sections of this report (those specifically related to maintenance and repair requirements) it can be noted that the motorized cylinder (called the Rayco cylinder) is at times incapable of opening the doors without drawing excessive amperage thus tripping a circuit breaker. Such a malfunction disables the control system, rendering it ineffective. While several factors affect the ability of the Rayco cylinder to open the exhaust duct doors, certainly the added resistance caused by the negative pressure in the duct with the butterfly damper welded shut contributes to the electrical overload.

At the Ford coking operations, several quench cars are used to service both "A" and "B" Batteries. Maintenance requirements necessitate that some quench cars without built-up ends and sides be used on the "A" and "AX" Batteries in conjunction with the control system. In the future, as other coke oven batteries at Ford are equipped with similar control systems, other quench cars will likely be modified. However, it should be noted that during some of the sampling conducted and reported the quench cars without built-up sides and end plates were in use. Records are not complete enough to indicate the sampling days when the unmodified quench cars were in use. However, indications are that the modified quench car was in use during more than 90 percent of the testing and evaluation program.

The emission control system, as indicated in the Koppers manual, was designed to service coke batteries which produce a minimum number of green coke pushes. When a large volume of combustible gases and products of combustion evolve during pushing, indraft velocities are insufficient to contain the fugitive emissions. This problem is compounded by the fact that the hood extends over only 30 feet of the 40-foot-long quench car. As the quench car necessarily moves under the hood to provide a level load of hot coke, a green push will continue to generate fugitive emissions in those sections of the car which are beyond the edge of the hood. In addition, although the hood is 30 feet long, the rectangular opening at the base of the hood is not 30 feet long. At the end of the actual hood opening, flat, horizontal plates provide a path for transporting emissions from the solid-plate portion of the hood into the suction area of the hood. When the baffle plates were removed, however, this solid plate area became largely ineffective in capturing emissions generated under it. Consequently, only about 50 percent of the quench car is under the effective hood area at any one time. During clean pushes, this is sufficient to capture much of the fugitive emission. In green pushes, fugitive emissions increase markedly. The estimated extent of this fugitive emission increase is presented in other sections of this report (see Section 6.4).

As reported in the design manual, exhaust gases discharging from the fan outlet pass directly into the base of the discharge stack. This configuration caused a noise problem at the outlet stack. To attenuate the noise, the airflow against the outer wall at the base of the stack was minimized by placing brick in the stack base to form a radius to turn the airflow. This decreased the noise and vibration levels measurably. To initially reduce the stack noise level, an acoustical silencer was installed in the outlet stack. The stack silencer consists of plates extending along the centerline of the stack in such a way as to divide the stack into two semicircles. The stack silencer extends from several feet above the top of the bricks at the base of the stack to the top of the stack. Before testing could be conducted for this project, it was necessary to install a stack extension that provided approximately 30 feet between the top of the stack and the top of the stack silencer. This modification was for test purposes only.

Again, these system modifications are evidently a necessary compromise to the original design configurations so that a reliably functional system could be ensured. As such, although tested in a modified state, this program provides an evaluation of a control system as it would likely exist on another battery of coke ovens and the harsh environment present there.

4.3 Operating Parameters

To provide the requisite air movement and capture efficiency at the hood, the induced draft fan was designed to provide a gas flowrate through the system of 112,000 ACFM at a nominal gas temperature of 132°F and a system static pressure less than -60 inches of water. The fan is driven by a 2,000-HP, 3-phase motor drawing approximately 240 amperes at 4160 volts when the fan inlet louvers are in the full open position. Between pushes, when the louvers are closed, the emission control system was designed to require approximately 1000 HP. Presented in other sections of this report are the actual exhaust volumes, temperatures, pressures, and utility and power requirements for actual operating conditions. Repetitive flow measurements indicate that the actual exhaust volume during a coke push is somewhat lower than the design flowrate. Further, inlet gas temperatures vary widely depending upon the degree of greenness of the coke push -- ranging typically from 100°F to over 700°F.

Calculations indicate that when no coke was being pushed into the quench car, the design flowrate would provide an indraft velocity of approximately 30 feet per second at the hood perimeter if the originally designed seal plates were in place. Settling and movement of the quench tracks and removal of the side seal plates have reduced indraft velocities to approximately 10 feet per second. Depending upon ambient weather conditions and the greenness of coke pushed, these indraft velocities were not always sufficient to capture the fugitive emissions efficiently. Capture efficiencies are documented in other sections of this report.

The venturi scrubber was designed to operate at a pressure differential of 60 inches of water. In practice, pressure differentials measured across the scrubber throat ranged from about 30 to 45 inches of water. This differential pressure drop existed both prior to and after replacement of all scrubber throat nozzles as documented by Ford maintenance personnel. This suggests that water spray coverage of the throat cross section is likely not responsible for its differential pressure being less than the design pressure drop.

As indicated, sound attenuation devices and flow alignment bricks in the outlet stack were installed. Undoubtedly, these devices provide a restriction to gas flow not anticipated in the original design. This is evident since the system was designed to operate at a pressure of -65 inches of water at the mist eliminator outlet (just upstream of the fan inlet), while, typically, about -48 to -55 inches of water pressure was measured at the mist eliminator outlet.

The scrubber requires approximately 890 gpm of recirculated water according to design criteria. Measured water flowrates were approximately at this value during the testing

documented in this report. However, historical operating data measured by the flow recording devices in the control room indicate that this flowrate varies considerably. These data indicate that water flow, determined as monthly averages, varies from about 600 to 1000 gpm.

The design manual presents calculations of operating costs and utility requirements based upon design data and a prescribed schedule which the system operator should follow. However, our observations show that the operator does not always operate the system in accordance with design criteria. During a typical 1-hour period of operation at the Ford Motor Company "A" and "AX" coke batteries, there are approximately four coke pushes. Design specifications mention that the collection hoods should be put in place approximately two minutes before the coke push. Since the coke push lasts approximately 40 seconds, utility requirements set forth in the design manual were based on two and one-half minutes of system operating per push or 10 minutes of full system operation during each push-hour. In actual practice, the operator is ready for the next push, including full activation of the emission control system, from two to 15 minutes before the push occurs. As previously indicated, because the quench car is shared among "A," "AX," and "B" Batteries, the coke guide operator on "A" and "AX" Batteries sometimes has a substantial interlude between coke pushes as determined by "A" and "B" coke battery scheduling. The effect of actual plant operation on utility costs is described in other sections of this report. However, it is noted that the total operating cost of this emission control system is affected materially by the production schedules and maintenance requirements at a particular multi-battery coke-making facility. Operator discretion is very important in determining actual operating costs.

The values of the operating parameters listed above are, in many cases, different from design values. Section 6.1.1 addresses the range of operating parameters encountered during the testing and evaluation program as they compare to average values computed from historical data recorded throughout the control system's life. The data indicate that the values of operating parameters listed above are characteristic of the control system's typical operation.

5.0 FIELD INVESTIGATION

This section describes the methodology of acquiring emission measurement data and process parameters. Prior to beginning this study, it was necessary to define pertinent operational parameters which must be monitored or measured to characterize both process and control system conditions. After the definition of these parameters, methods of measurement and data acquisition were specified to ensure that the necessary information could be obtained in the most accurate manner possible.

To determine what samples had to be acquired to characterize emission rates and collection efficiencies, the nature of the emissions was defined by literature investigation and range-finding tests at the scrubber inlet where concentrations are at a maximum. For each emission species detected, appropriate sampling and analytical methods at the scrubber inlet and outlet were chosen to assure accurate assessment of scrubber efficiencies for the control system.

From the earliest phases of this investigation, it was obvious that any complete and meaningful evaluation of the Ford/Koppers coke-pushing control system must include an analysis of the uncaptured coke-pushing emissions which appeared to be a significant portion of the total push particulate emissions. However, to characterize the extent of fugitive emissions into the ambient air at the hood inlet, it was necessary to utilize a sampling technique which provides a good estimate of hood capture efficiency.

Proven and accepted methods for quantifying fugitive emissions do not exist, although the state-of-the-art continues to develop steadily. Because of the visual appearance of uncaptured push emissions and the availability of large numbers of pushes from which to judge the degree of capture of the control system, it was decided that a subjective estimate of effectiveness of hood capture would be an important component in the analysis of overall system performance.

The estimated hood capture efficiency, applied to the appropriate techniques to assess accurately the measured inlet emissions, provides an estimate of the mass rate of fugitive emissions. From this estimate and the measured scrubber outlet emissions, a range of total, overall efficiencies of the control system could be calculated to determine an estimate of total abatement efficiency of the coke-pushing emissions. The test results were then normalized with respect to process performance characteristics so the information could be extrapolated to similar coke oven batteries in other plants. Consequently, it was necessary to define process conditions and develop efficient methods to acquire all necessary process data for each push measured during the study.

5.1 Methodology of Data Acquisition

In fulfilling the project objectives it was necessary to: 1) document historical performance, 2) document historical economics, 3) determine system operability, 4) measure scrubber performance, and 5) evaluate the emission control system and its applicability to other coke oven batteries.

5.1.1 Documentation of Historical Performance

The emission control system was installed in June, 1972. Therefore, it was necessary to evaluate written records which characterize the operating and maintenance requirements for the emission control system. These data were then updated by an engineer-observer from Clayton Environmental Consultants, Inc., who acquired field data intermittently between August, 1974 and August, 1975.

Correlations (developed in latter sections of this report) relate overall scrubber efficiency and hood capture efficiencies to certain design parameters which are recorded routinely by coke oven personnel. Written records included: 1) "Operating Checks on Smokeless Coke Pushing Emission Control System Once Each 8-hour Shift by the Coke Battery Foreman," 2) " 'A' Coke Battery Door Machine Downtime," 3) "Operating Checks on the Smokeless Coke Pushing Emission Control System Once a Week on Saturday by the Second Shift General Foreman," 4) "Maintenance Department Logbook," and 5) "Operations Department Logbook."

The written records of the daily operating checks conducted by the coke battery foreman contain: fan bearing temperatures; motor bearing temperatures; fan amperage requirements before and during a coke push; gas temperatures at the exhaust duct and Kinpactor inlet, fan inlet, and the fan discharge stack; Kinpactor differential pressure drop both between and during coke pushes; water flowrate to the Kinpactor; pressure at the water pump and which of the two pumps is operating; an observation before noon of one coke push to determine the stack opacity. In addition, ancillary notes are written at the bottom of these sheets as deemed appropriate by the coke battery foreman to characterize the emission control system performance. A specimen of this document is provided in Figure 5.1.1-1. These data are used to calculate utility requirements as they actually occurred throughout the lifetime of the emission control system.

The "A" coke battery door machine downtime is documented in a notebook kept by the coke oven personnel. This record was kept routinely even before installation

of the "Smokeless Coke Pushing System." Subsequent to modification of the "A" coke battery door machine necessitated by installation of the emission control system for "A" and "AX" battery, records were kept of downtime attributable to the door machine itself (that is, actual door machine failures independent of the control system). In determining actual emission control system maintenance, these records were researched for entries pertaining to downtime associated only with the "Smokeless Coke Pushing System." A specimen of this document is included in Figure 5.1.1-2.

The weekly operating checks by the general foreman document: oil levels in the fan bearings and pumps, pump performance, Kinpactor spray header pressures, and records of when Kinpactor sprays were reamed. Additionally, ancillary notes are recorded at the bottom of these sheets which document the emission control system performance deemed important by the general foreman. A specimen of this record is provided in Figure 5.1.1-3. These records were researched for pertinent entries which document unusual performance of the emission control system and to assure that proper maintenance was performed routinely as required by the preventive maintenance schedule.

The maintenance department logbook contains entries pertaining to all coke batteries serviced by the maintenance department. Even for "A" coke battery, maintenance work performed upon the "Smokeless Coke Pushing System" is interspersed with regular maintenance performed on "A" coke battery. Approximately 16 volumes of the maintenance department logbooks were researched to extract entries which pertained only to the "Smokeless Coke Pushing System." Figure 5.1.1-4 includes a specimen of the typical notes contained in maintenance logbooks. Entries pertaining to the coke pushing emission control system maintenance are presented completely in Appendix A.

The operations department logbook summarized operational problems or difficulties associated with "A" and "B" coke batteries. The only logbooks available for perusal which pertained to the emission control system were entries beginning in March, 1975 and extending to August, 1975. A typical specimen of these entries is shown in Figure 5.1.1-5. A complete listing of logbook entries pertaining to the emission control system is contained in Appendix A.

These sources of information constitute all available documents which can be used to characterize the historical performance during the lifetime of the coke pushing emission control system.

5.1.2 Documentation of Historical Economics

Any attempt to characterize dollar value expenditures throughout the history of the emission control system should inherently include costs associated with operation of the system; these are composed of utility costs and maintenance costs. While it is straightforward to obtain utility costs by extrapolation of fan and pump horsepower ratings, more accurate utility requirements and costs can be determined by researching available records which document actual utility usage. Similarly, maintenance costs can be approximated by attempting to estimate man-hours expended and multiplying by the cost per man-hour. However, such an approach leads to erroneous maintenance costs because maintenance records are inherently designed to document the causes of downtime and, as can be seen by inspection of maintenance records, do not include actual man-hour requirements to effect the necessary repairs.

Consequently, it was necessary to investigate cost accounting files and control codes to determine actual maintenance costs (labor and material) associated with the emission control system. Two methods of cost accounting procedures were investigated to document historical economics. The first method included review of overall cost control codes associated with: 1) coke battery pollution control including labor and parts for the "A" and "AX" emission control system, and 2) pollution control by-products cost of disposal. Two 4-digit cost codes were obtained from cost accounting personnel and all computer records of year-to-date totals associated with these two cost codes were researched.

Upon the advice of cost accounting personnel that these records were conglomerates and did not necessarily reflect all costs associated with the system, a second method of cost accounting was researched. In this method, a special detailed 4-digit cost code (which is a subcontrol code of the major cost codes) was used to obtain monthly totals of "maintenance labor requirements" and "stores payable cost requirements." These control codes were established specifically by the cost accounting department to provide the most accurate possible measure of costs associated with the emission control system. The results of these documentary investigations are displayed in other sections of this report.

5.1.3 Determination of System Operability

Simultaneous with all testing, an on-site engineer-observer recorded certain key operational variables necessary to characterize hood capture efficiency. Figure 5.1.3-1 displays a specimen of the daily log of hood performance used to record the engineer-observer's data regarding hood capture. These data include: the oven number pushed, the scheduled push time, the actual push time, the measured cross-draft wind velocity measured in the hood proximity, the estimated hood capture efficiency, the stack opacity, the condition of the push as determined on the coke side, and the net amount of coal charged to the oven just pushed.

Cross-draft wind velocity measurements were made with a hand-held vane-axial anemometer facing into the wind and held by the engineer-observer located about 200 feet west of "A" Battery.

The hood capture efficiency recorded on the data sheet shown in Figure 5.1.3-1 was obtained by visual estimation of the percentage of emissions emanating from the quench car which were collected by the hood. Although this is a semi-quantitative determination, the degree to which this measurement corresponds to another estimate of fugitive emissions (obtained by high-volume air sampling) is discussed in other sections of this report. In general, any engineer-observer visually estimating hood capture efficiency relied upon a "conceptual record" of uncontrolled push emissions for a given greenness to judge and compare the visible fugitive emissions to the uncontrolled emissions characteristic of that type of push. The opacity of the fugitive emissions is a useful aid in categorizing the type of push observed and judging the magnitude of an uncontrolled push.

Figure 5.1.3-2 is a schematic diagram showing the approximate locations of the engineer-observer during the push. The location varied, due to line-of-sight restrictions, depending upon the oven pushed.

Stack opacity was determined by certified opacity readers, in most cases. While the majority of stack opacity measurements were made by individuals who had successfully completed an EPA-approved course in opacity reading, all opacity readings were taken by individuals who had extensive experience in evaluating visible emissions and who were oriented and trained at the field site by certified opacity readers.

"Coke-side condition" was a subjective judgment recorded by the engineer-observer to document whether the push was "green," "medium," or "clean." (Clayton used these three categories; Ford personnel used only two classifications.) Net coal charged was obtained from process data records.

The daily log of hood performance was recorded for nearly all times during which actual testing occurred. At other times, the engineer-observer was stationed at the fan where he recorded data pertinent to the scrubber performance evaluation.

5.1.4 Measurement of Scrubber Performance

To characterize the scrubber performance, it was necessary to determine both the scrubber operating parameters and the actual inlet and outlet scrubber emission rates. Emission rate determinations are discussed in Section 5.2 of this report. To characterize the scrubber performance parameters, the engineer-observer recorded data on data sheets of the type displayed in Figure 5.1.4. When tests were not being conducted, the engineer-observer was present at the fan to record data on the "Daily Log of Scrubber System Performance." In addition, these scrubber operating conditions were also recorded by the sampling crew during the course of performing inlet and outlet source testing.

As indicated in Figure 5.1.4, this data sheet contains information which includes: the number of the coke oven just pushed; push time; conditions existing at the scrubber inlet, including dry-bulb temperature, wet-bulb temperature, static pressure, and velocity pressure; scrubber throat conditions, including pressure drop, water pressure, and water temperature; scrubber outlet conditions, including dry-bulb temperature, wet-bulb temperature, and static pressure; recirculated water flowrate to the scrubber; and the fan motor current. Several weeks of pretest observations established that the scrubber throat conditions, scrubber outlet conditions, recirculated water flowrate, and fan motor current were quite constant during a day's testing and even during several days of testing. Inlet scrubber conditions varied somewhat depending upon the "greenness" of the coke push. These system measurements, as just noted, remained quite constant. Therefore, the engineer-observer recorded these measurements only a few times during the day to adequately characterize the performance of the emission control system. At other times, the engineer-observer accumulated hood capture data.

Because the scrubber inlet and outlet are at different elevations approximately 35 feet apart, it was not possible for the engineer-observer to physically traverse the distance between the inlet and outlet during the 40-second duration of a push. Consequently, the inlet dry-bulb temperature measurement, and the inlet static and velocity pressures were measured remotely at the scrubber outlet by means of thermocouples connected to a potentiometer and tubing connected to an inclined draft gauge, respectively. Scrubber outlet dry- and wet-bulb temperatures were measured directly at the elbow leading from the mist eliminator outlet to the fan inlet. Scrubber outlet static pressure was measured at that location using a mercury manometer. A differential pressure gauge installed near the fan permitted the engineer-observer to record scrubber throat pressure drop during a coke push. Water pressure was recorded by observing gauges on the scrubber pumps located in the pump house near the fan. Water temperature was obtained by opening a valve on the inlet water line and allowing the water to run for several minutes before taking the water temperature using a mercury thermometer. At the end of each day's testing the engineer-observer would record the recirculated water flowrate and fan motor current from the strip chart recorders located in the "A" and "B" coke battery control room. These recorders are the same recorders used by the Ford personnel in filling out their records of system operation discussed in Section 5.1.1.

5.1.5 System Evaluation and Applicability

To normalize all maintenance requirements, maintenance and operation costs, hood collection efficiency, and scrubbing efficiency, certain process parameters were obtained to characterize the push sampled. Figures 5.1.5-1, -2, and -3, respectively, display specimens of the coke oven heater inspection report, coal charge log, and oven temperatures, as they are recorded by Ford Motor Company personnel on a routine basis. These documents provide all available data to characterize those process parameters which determine, to the extent possible, emissions generated during a coke push which must be abated by the control system.

The coke oven heater inspection report is used to determine the time delay from the scheduled to the actual coke push. This report also documents the Ford Motor Company quench car operators' appraisal of the coke's condition on the coke side of the oven during the push. The two designations used by Ford personnel include "fire and smoke" (not analogous to

the fire and smoke designation used by the Clayton engineer-observer) and "good." The latter category designates a relatively clean coke push. These data were used to determine the correlation between the engineer-observer's and the Ford Motor Company personnel's observations of coke push condition.

The coal charge log documents the time when a particular oven was charged with coal. The net weight of coal charged is obtained from a printing recorder located in the "A" and "B" coke battery control room. Each larry car is weighed upon receiving a charge of coal which is completely emptied into a coke oven.

The coke oven temperature data sheet documents temperatures measured once each shift by Ford Motor Company personnel using an optical pyrometer. Temperature measurements are taken at portholes located on the roof of each oven on the push and coke sides. The data are needed in attempts to predict the "degree-of-greenness" of a push as it relates to coking temperature. Results of the attempted correlation are discussed in other sections of this report.

5.2 Emissions Measurement

At the onset of this project in 1974, a literature investigation was performed to provide a roster of emissions produced by the coking process. Based upon extensive experience with sampling of other coke pushing emission effluents, the list of suspect contaminants was later refined and expanded to include the total contaminant roster displayed in Table 3.2-2. Range-finding tests were then conducted intermittently during the first four months of 1975. From these data, average coke pushing emission rates were documented for many of the compounds in Table 3.2-2 that were expected to exist in low or immeasurable concentrations. Based upon these data, certain contaminants were excluded from the roster for subsequent source testing conducted during June and July of 1975.

The comprehensive source sampling project thus included both the range-finding tests conducted during the first four months of 1975 and the further, subsequent testing conducted during June and July. Those contaminants included in this comprehensive source sampling project were the following: ammonia, hydrogen sulfide, phenolics, sulfur dioxide, sulfur trioxide, total sulfur oxides, nitrogen oxides, benzene and homologues, pyridine, carbon disulfide, carbon monoxide, ethylene and homologues, total light hydrocarbons, methane and homologues, acetylene, naphthalene, fluorene, 9-fluorenone, phenanthrene, anthracene, acridine, carbazole, fluoranthene, pyrene, chrysene, benzo(a+e)pyrene, acrolein, chlorine, cyanide, and

total reduced sulfur. In addition, particle sizing tests and particulate loading tests were conducted.

The following subsections present a description of the sampling and analytical methods used to measure contaminants at the wet scrubber inlet and outlet sampling locations. During range-finding tests, samples were collected only at the inlet location, and following range-finding tests, sampling for some contaminants was performed only at the scrubber outlet. This sampling at the outlet only was carried out to further document the low or immeasurable concentrations found at the inlet. In all cases of scrubber efficiency measurements, however, sample collection at the outlet was simultaneous with sample collection at the inlet.

Figure 5.2 indicates that sampling at the inlet location was conducted through each of two ports in the 66-inch diameter horizontal duct immediately upstream of the scrubber. Approximately 30 feet of straight duct upstream and four feet downstream of the sampling ports yielded a uniform velocity profile at this sampling location.

Four ports located 90 degrees apart were positioned at the 90-inch diameter outlet location, as shown in Figure 5.2. At this location, approximately 23 feet of straight duct below the sampling ports and seven feet of straight duct above the sampling ports provided a fairly uniform velocity profile.

Sampling methods used at both locations followed the principles outlined in "Standards of Performance for New Stationary Sources,"(5) presented in detail in Appendix B. The sampling location and marking of sampling points followed a modified version of EPA Method 1. This modification involved using fewer sampling points than the method requires for the location of the sampling point upstream and downstream of potential disturbances. Due to the pushing schedule, it was impracticable to sample at the number of points required. Even during the course of the actual sampling it was necessary to reduce the number of sampling points from 24 to 16 in order to obtain a particulate sample in a reasonable length of time.

Velocity traverses were conducted according to EPA Method 2, and exhaust gas composition and moisture content were determined according to EPA Methods 3 and 4, respectively.

Because of the intermittent nature of this emission source, sampling was conducted only during the brief periods of coke oven pushing. Typically, the push on "A" Battery at the Ford Rouge Plant requires about 40 seconds to be completed while about 60 seconds are required to completely evacuate the control system and ductwork of push emissions. All non-grab samples spanned this one-minute period. Sampling commenced

as coke first fell into the quench car and continued until either the designated period of sampling had elapsed or until the snorkle was removed.

The field data sheets for all source sampling are presented in Appendix C. Calibration data for all Pitot tubes, dry-gas meters, and critical orifices used in the study are presented in Appendix D. Appendices E and F present sample calculations and project participants, respectively.

Thirty-two emission species were sampled and analyzed during the source sampling phase of the project; however, somewhat less than 32 different sampling methods were employed because aliquots of a collected sample could often be analyzed for several contaminants. A description of each of the sampling methods follows with subsections under each method describing the analytical methods used for each of the contaminants collected in that sample.

5.2.1 EPA Method 5 Sampling

The particulate sampling method very closely followed that outlined by EPA Methods 1 through 5 (Appendix B). Particulate was withdrawn from the stack isokinetically through a stainless steel probe to a heated glass-fiber filter. Non-filterable particulate was captured subsequently in three impingers containing 200 ml of distilled water. The volume of sampled gas was measured with a calibrated dry-gas test meter. Sampling rates were established using an orifice meter and inclined manometer. Skilled sampling team members, having extensive experience with the temperature and velocity pressure fluctuations characteristic of the push emissions captured in the inlet ductwork, were able to attain excellent isokineticity.

The percent isokineticity ranged from 100.0 to 108.6 and averaged 105.4 during the test series at the inlet. At the outlet, percent isokineticity ranged from 102.2 to 113.2 and averaged 107.3 during the nine particulate test series. Calculation of the percent of isokineticity on a push-by-push basis yielded similar results. Within each one-minute sampling period, conditions of velocity pressure and stack temperature varied considerably. Adjustments in sampling rate were made within each sampling period as well as between sampling points. Rapid adjustment was facilitated by the fact that the "fine" setting on the meter console could be adjusted during sampling at one point. Closing the "coarse" valve without adjusting the "fine" valve resulted in a similar sampling rate when the coarse valve was opened again. Fortunately, the required flowrate from point to point did not vary greatly. Calculation of

required flowrate was done with a portable electronic calculator and was facilitated by charts of the required rate at various velocity pressures and stack temperatures.

5.2.1.1 Particulate

Filterable particulate includes those fractions captured in the acetone rinse of the sampling probe and on the glass-fiber filter. Condensibles are determined from the residues after evaporation of the impinger solution.

In the laboratory, the acetone probe wash was evaporated to a constant weight at room temperature and subsequently weighed on an analytical balance capable of sensing 0.1 milligram. The glass-fiber filter was brought to a constant weight in a desiccator and was similarly weighed. Aqueous impinger solutions were extracted repeatedly with a mixture of chloroform-ether that separated the organic materials from the inorganic materials. Both the aqueous and chloroform-ether solutions were subsequently dried to a constant weight and weighed on an analytical balance. The analysis of the filters and solutions paralleled that of the particulate samples, and particulate weights were appropriately adjusted for blank values.

5.2.2 EPA Method 8 Sampling

The sampling train consisted of a sampling nozzle, a glass-lined probe, a heated 110-ml glass-fiber filter, a Greenburg-Smith impinger containing 100 ml of 80-percent isopropyl alcohol, and two impingers each containing 100 ml of 3-percent hydrogen peroxide. The impingers and a condensate trap containing silica gel were immersed in an ice bath.

The sampled gas was drawn at approximately one CFM by means of a vacuum pump through a calibrated dry-gas meter where the temperature and the pressure of the gas were measured, then through a calibrated orifice meter. After each test the contents of the first impinger and that of the second and third impingers were transferred to two separate sample bottles for transport to the laboratory. The volume of the metered gas was determined from the initial and final readings of the gas meter. The average meter pressure and temperature were used to calculate the sampled gas volume at standard conditions.

5.2.2.1 Sulfur Dioxide

An aliquot portion of the hydrogen peroxide sample solution was transferred to an Erlenmeyer flask. Isopropyl alcohol was added to make an 80-percent isopropyl alcohol solution and two to four drops of thorin indicator were added. The solution was then titrated with standardized barium perchlorate solution to a pink endpoint. The results were reported as sulfur dioxide.

5.2.2.2 Sulfur Trioxide

An aliquot portion of the isopropyl alcohol sample solution from the first impinger was transferred to an Erlenmeyer flask. Two to four drops of thorin indicator were added. The solution was then titrated with standardized barium perchlorate solution to a pink endpoint. The results were reported as sulfur trioxide.

5.2.3 Sodium Hydroxide Sampling

The sampling train consisted of a sampling nozzle, a glass-lined probe, a heated glass-fiber filter, and two Greenburg-Smith impingers, each containing 150 ml of 0.1-N sodium hydroxide. The impingers and a condensate trap containing silica gel were immersed in an ice bath.

The sampled gas was drawn at approximately one CFM by means of a vacuum pump through a calibrated dry-gas meter where the temperature and the pressure of the gas were measured, then through a calibrated orifice meter.

After each test, the impinger contents and the rinsings of the impingers were transferred to sample bottles for transport to the laboratory. Similarly, the probe was rinsed with the sodium hydroxide solution, and the filter was added to the rinsings. "Filterable" material was captured in this sample fraction.

The volume of metered gas was determined for the initial and final readings of the gas meter. The average meter pressure and temperature were used to calculate the sampled gas volume at standard conditions.

5.2.3.1 Chlorine

An aliquot of each of the resulting impinger solutions was mixed with O-tolidine. The absorption at 438 nanometers (nm) of yellow product was compared with those of standards prepared in the laboratory.

5.2.3.2 Cyanide

An aliquot of the resulting solution was placed in a beaker and appropriately buffered. A cyanide ion-selective electrode and reference cell were placed in the resulting solution and the response detected by a laboratory millivolt meter was compared with that from standards of cyanide prepared in the laboratory.

Due to relative instability of cyanide samples, analyses were conducted as soon as possible after sample acquisition.

5.2.3.3 Total Phenolics

Aliquot portions of the probe wash and filter fraction and the impinger catch fraction were kept refrigerated to prevent loss of phenol. In the laboratory, the pH of a 50-ml aliquot was adjusted to less than four with a 50-percent phosphoric acid reagent. The phenol was steam distilled from a glass still. After distilling, a 10-ml quantity of distilled water was added to the still and heating was resumed until an additional 10-ml volume of distillate was collected. The total volume of the distillate was recorded and a 6-microliter portion was analyzed by gas chromatography using a 5-percent Carbowax 20 M liquid phase on a Diatoport 80/100 S solid support in a 1/4-inch stainless steel column operated at 170°C and a hydrogen flame ionization detector. The phenol concentration in the distillate was obtained in terms of parts per million in solution by referring the phenol peak area to those phenol standards prepared at the same time.

5.2.3.4 Total Sulfur Oxides

An aliquot portion of the sodium hydroxide solution captured in the impingers and an aliquot of the solution from the aqueous probe wash and corresponding glass-fiber filter were combined with sufficient barium chloride to result in the formation of barium sulfate with an excess of barium. The turbidity of the resulting suspension of barium sulfate was measured using an ultraviolet spectrophotometer and the absorbance at 494 nm compared with standard solutions prepared in the laboratory.

5.2.4 EPA Method 7 Sampling

The sampling and analytical procedure for nitrogen oxides follows the procedure outlined in EPA Method 7 (Appendix B). Briefly, this method includes the evacuation of a 2-liter flask containing 25 ml of 0.02-percent hydrogen peroxide — 0.03-percent sulfuric acid reagent. The flask is subsequently filled with exhaust gas through a purged probe system. The sampled gas volume is determined from the measurement of the volume, temperature, and pressure of the sample flask.

5.2.4.1 Nitrogen Oxides

A small volume of dilute sulfuric acid and hydrogen peroxide absorbs the oxides of nitrogen upon standing. In the laboratory, phenol disulfonic acid solution is added to the resulting solution and the absorbance of the resulting solution is measured at 420 nm and compared with the absorbance of known standards prepared in the laboratory.

5.2.5 Grab Sampling

Exhaust gas samples were drawn by a vacuum pump through a probe and a short (less than one foot) section of Tygon tubing to a gas sample container with stopcocks at the inlet and outlet of the container, and then through a flowrate meter. By minimizing the length of tubing, the wall effects associated with this type of tubing are considered minimal. Exhaust gas thoroughly flushed the contents of the gas collection container and tubing to ensure that air was completely displaced. Subsequently, stopcocks at the container inlet and outlet were closed.

5.2.5.1 Acetylene

An aliquot of the gas sample was injected into a gas chromatograph with a syringe. A Carbowax column separated the acetylene which was subsequently measured with a flame ionization detector operated at 90°C using 40 ml of helium carrier gas per minute. The peak produced was identified and compared with those produced by known standards in gas mixtures prepared in the laboratory.

5.2.5.2 Carbon Monoxide

An aliquot of the gas sample was injected into the gas chromatograph with a syringe. A molecular sieve 13X column separated the carbon monoxide which was subsequently measured with a thermoconductivity detector maintained at 50°C. The peak produced was identified and compared with those produced by known standards in gas mixtures prepared in the laboratory.

5.2.5.3 Ethylene and Homologues

An aliquot of the gas sample was injected into a gas chromatograph with a syringe. A Carbowax column separated the ethylene and homologues which were subsequently measured with a flame ionization detector operated at 90°C using 40 ml of helium carrier gas per minute. The peak produced was identified and compared with those produced by known standards in gas mixtures prepared in the laboratory.

5.2.5.4 Methane and Homologues

An aliquot of the gas sample was injected into a gas chromatograph with a syringe. A Carbowax column separated the methane and homologues which were subsequently measured with a flame ionization detector operated at 90°C using 40 ml of helium carrier gas per minute. The peak produced was identified and compared with those produced by known standards in gas mixtures prepared in the laboratory.

5.2.5.5 Total Light Hydrocarbons

An aliquot of the gas sample was injected into a gas chromatograph with a syringe. A Carbowax column separated the total light hydrocarbons which were subsequently measured with a flame ionization detector operated at 90°C using 40 ml of helium carrier gas per minute. The peak produced was identified and compared with those produced by known standards of gas mixtures prepared in the laboratory. Results were reported as total light hydrocarbons as methane.

5.2.6 Activated Charcoal Sampling

The sampling train consisted of a stainless steel probe, polyvinyl chloride tubing, and a glass tube containing activated charcoal. The tubing length used to transport the gases from the probe to the charcoal tube was kept to a minimum length — approximately one foot. This minimized wall effects as possible sources of interferences. The sampled exhaust gases were drawn at approximately one liter per minute through a calibrated dry-gas test meter, where the temperature and pressure of the gases were measured, and through a flowrate meter by means of a vacuum pump. The tube containing the activated charcoal was capped for transport to the laboratory.

The volume of metered gas was determined from the initial and final readings of the gas meter. The average meter pressure and temperature were used to calculate the sampled gas volume at standard conditions.

Based upon Clayton Environmental Consultants' prior experience in the use of activated carbon for organic species sampling, the organic materials sample in this study using this method are considered to be quantitatively absorbable and desorbable using carbon disulfide as the eluent.

5.2.6.1 Benzene and Homologues

Benzene and homologues of benzene which were absorbed on the activated charcoal were desorbed by stirring the charcoal with carbon disulfide (1.5 ml CS_2 per gram charcoal) for a minimum of 30 minutes.

An aliquot of the sample was injected into a gas chromatograph containing a 5-percent Carbowax 20M TPA 2' x 1/4" column operated at

60°C. The eluted fractions were measured by means of a flame ionization detector. The peak areas produced by benzene and its homologues were measured and compared with those produced by known concentrations of the standards prepared in the laboratory.

5.2.6.2 Carbon Disulfide

The carbon disulfide absorbed on the activated charcoal was desorbed by stirring the charcoal with ethanol (1.5 ml ethanol per gram charcoal) for a minimum of 30 minutes.

An aliquot of the sample was injected into a gas chromatograph containing a 20-percent Carbowax 20M TPA 4' x 1/4" column operated at 80°C. The eluted fractions were measured by means of a thermoconductivity detector. The peak areas produced by carbon disulfide were measured and compared with those produced by known concentrations of the standards in gas mixtures prepared in the laboratory.

5.2.6.3 Pyridine

The pyridine which was absorbed in the activated charcoal was desorbed by stirring the charcoal with ethanol (1.5 ml of ethanol per gram of charcoal for a minimum of 30 minutes).

An aliquot of the sample was injected into a gas chromatograph containing a 5-percent Carbowax 20M TPA 2' x 1/4" column operated at 60°C. The eluted fractions were measured by the flame ionization detector. The peak areas produced by pyridine were measured and compared with those produced by concentrations of standards prepared in the laboratory.

5.2.7 EPA Method 11 Sampling

The sampling and analytical method for hydrogen sulfide followed exactly the procedure of EPA Method 11 (Appendix B). Briefly, the method includes the capture of hydrogen sulfide gas in a cadmium hydroxide solution in midget impingers immersed in an ice bath. The volume of sampled gas was measured with a dry-gas test meter.

5.2.7.1 Hydrogen Sulfide

Analysis of the sample was conducted immediately after sample collection because of the instability of the resulting solution. A known quantity of iodine solution was added to the cadmium hydroxide solution and was subsequently back-titrated with a standard solution of sodium thiosulfate. The amount of hydrogen sulfide in the sample was calculated from the excess of iodine beyond that neutralized by the thiosulfate.

5.2.8 Sulfuric Acid Sampling

The sampling train consisted of a sampling nozzle, a glass-lined probe, a heated 110-mm glass-fiber filter and two Greenburg-Smith impingers each containing 150 milliliters of dilute sulfuric acid. The impingers and a condensate trap containing silica gel were immersed in an ice bath.

The sampled gas was drawn at approximately one CFM by means of a vacuum pump through a calibrated dry-gas meter where the temperature and pressure of the gas were measured, then through a calibrated orifice meter.

After each test the impinger contents and the rinsings of the impingers were transferred to sample bottles for transport to the laboratory. The volume of metered gas was determined from the initial and final readings of the gas meter. The average meter pressure and temperature were used to calculate the sampled gas volume at standard conditions.

5.2.8.1 Ammonia

The total volume of the sample solution was measured and a 10-ml portion was transferred to a 50-ml Griffin beaker to which a 4-ml quantity of 0.2-molar sodium citrate reagent was added. The pH of the solution was adjusted to 7.5 using dilute acid and base and an expanded scale pH meter. The final volume was adjusted to 20-ml with 0.2-molar sodium citrate. The ammonium ion potential of the solution was measured using the millivolt mode of a Sargent Model DR pH meter and an Orion ammonia ion-selective electrode, used in conjunction with an Orion single junction reference electrode. The ammonia content (as NH_3) of the sample was calculated

by reference to a standard curve prepared by application of the procedure to a series of samples of known ammonium content.

5.2.9 Ethanol Sampling

The sampling train consisted of a sampling nozzle, a glass-lined probe, and two midget impingers containing 30 milliliters of ethanol. The impingers and a condensate trap were placed in an ice bath. The sampled gas was drawn at approximately one CFM by means of a vacuum pump through a calibrated dry-gas meter where the temperature and pressure of the gas were measured.

After each test the impinger contents were transferred to sample bottles for transport to the laboratory. The volume of metered gas was determined from the initial and final readings of the gas meter.

5.2.9.1 Acrolein

An aliquot of the resulting solution was mixed with 4-hexylresorcinol in an ethyl alcohol trichloroacetic acid solvent in the presence of mercuric chloride. The absorption at 605 nm of the blue product was compared with standards prepared in the laboratory.

5.2.10 Cyclohexane Sampling

The sampling train consisted of a sampling nozzle, a glass-lined probe, a heated 110-mm glass-fiber filter, and two Greenburg-Smith impingers each containing 150 milliliters of cyclohexane. The impingers and a condensate trap containing silica gel were immersed in an ice bath.

The sampled gas was drawn at approximately one CFM by means of a vacuum pump through a calibrated dry-gas meter where the temperature and pressure of the gas were measured, then through a calibrated orifice meter.

Similarly, the probe was rinsed with cyclohexane and the filter was added to the rinsings. "Filterable" material was captured in this sample fraction.

After each test, the impinger contents and the rinsings of the impingers were transferred to sample bottles for transport to the laboratory. The volume of metered gas was determined from the initial and final

readings of the gas meter. The average meter pressure and temperature were used to calculate the sampled gas volume at standard conditions.

To minimize the effects of interferring substances having the same retention time in the gas chromatograph as the compound of interest thus biasing the results obtained from this type of sampling, exacting standards-preparation procedures and blank-correction procedures were designed and carefully executed. For each compound of interest (delineated below), the chromatogram peak areas were adjusted according to standards and according to replicate analysis performed on the pure solvents and on field blanks. Further, Clayton's laboratory experience with similar coke-oven studies provided expertise helpful in recognizing and minimizing interference problems in the analytical techniques.

5.2.10.1 Acridine

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column, in an oven temperature programmed from 165°C to 300°C at 4°C per minute. A flame ionization detector indicated acridine in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.2 Anthracene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of anthracene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.3 Benzo(a+e)pyrene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the benzo(a+e)pyrene in the sample. The peak was compared with those produced by known

standards in gas mixtures prepared in the laboratory.

5.2.10.4 Carbazole

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the carbazole in the sample. The peak was compared with those produced by known standards in gas mixtures prepared in the laboratory.

5.2.10.5 Chrysene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W co umn operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of chrysene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.6 Fluoranthene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of fluoranthene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.7 Fluorene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of fluorene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.8 9-Fluorenone

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of 9-fluorenone in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.9 Naphthalene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of naphthalene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.10 Phenanthrene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of phenanthrene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.10.11 Pyrene

An aliquot of each solution was injected into a gas chromatograph containing a 6-percent, Dexsil 300 on an 80/100 Chromosorb W column operated at 165°C to 300°C at 4°C per minute. A flame ionization detector indicated the presence of pyrene in the sample. The peak was compared with those produced by known standards prepared in the laboratory.

5.2.11 Integrated Sampling

Exhaust gas samples were drawn by a diaphragm pump through a probe and tubing to a Tedlar® bag. A valve at the inlet to the bag was then closed. The gas sample in the bag was transported to the laboratory for analysis.

5.2.11.1 Total Reduced Sulfur

An aliquot of the gas sample was introduced into a gas chromatograph. A 3-percent OV-1, 80/100 mesh Chromosorb separation column (6' x 1/4") isolated the total reduced sulfur compounds which were subsequently measured with a flame photometric detector. The peaks produced were identified and compared with those produced by known standards in gas mixtures prepared in the laboratory of Ontario Research Foundation, a subcontractor to Clayton.

Due to the tendency of reduced sulfur compounds to degrade rapidly, the gas samples were analyzed as soon as possible after sample acquisition. Because the analyses for total reduced sulfur require non-portable analytical instrumentation, the samples were transported to the laboratory and analyzed within 24 hours.

5.2.12 Andersen Impactor Sampling

The size distributions of particles at the inlet and outlet sampling locations were determined by using an Andersen impactor. Exhaust gases were drawn from the stack gas and passed through a series of impaction nozzles and plates which collect particles of progressively smaller aerodynamic size. Those particles not impacted on the final stage were captured on a glass-fiber filter located behind the impaction separator.

During the sampling for particulate size distribution, the flowrate through the impactor was chosen so as to provide as near as possible an approximation to isokineticity at the single point of sampling in the duct cross-section. The expected velocity pressure at the sampling point was determined from velocity pressure measurements made in previous tests for particulate emissions. Once set, that flowrate through the impactor was maintained throughout the push duration.

5.2.12.1 Particle Sizing

The weight of material captured on each stage was subsequently determined in the laboratory on an analytical balance. The final filter was also weighed in the laboratory on an analytical balance. The relative quantity

of weight captured on the various impaction stages and the final filter indicates the size distribution of collected particulate materials. Subsequently, the density of particulate was determined in the laboratory by a pycnometer in order to establish the "cut-off" diameter for the various impactor stages.

The operating instructions for the Andersen impactor prescribe that certain correction factors be applied to the size distribution results and cut-off diameter for each stage. The unit has been calibrated by the supplier for spherical, unit-density particles. Separation, based on the particle's inertia, from stage to stage depends upon the particle's aerodynamic diameter. Charts provided by the supplier permit calculation of actual cut-off diameter for each stage for the particular material being sampled and the actual stack gas sampling conditions. The multiplicative correction factor for particle density requires that a density determination be made which is not a bulk density type measurement but, rather, it must estimate, as closely as possible, the density of the discrete material as it existed under stack gas conditions.

5.2.13 Fugitive Emissions Measurement (Method 1)

In an attempt to corroborate estimates of fugitive particulate emissions made by the visual judgment method described in Section 5.1.3 (Method 2), a sampling technique was developed using a combination of photography and particulate concentration measurements in the plume of the fugitive emissions. This technique is termed "Method 1." Although well-defined, widely-accepted procedures exist for the measurement of emissions which are confined in a duct or stack, standardized procedures for the measurement of fugitive emissions are non-existent. Access to the collection hood and the potentially-hazardous environment near the hood during coke pushing are two factors that constrain the scope of the technique to one of simplification and relative ease of implementation.

Fugitive emissions were thus estimated by two separate techniques in order to assess their contribution to total pushing emissions: 1) consideration of the relative fugitive plume concentration both when emissions were completely uncontrolled and when the emission control system was in operation; and 2) subjective evaluation by an engineer-observer. This section describes the first of these two techniques.

5.2.13.1 High-Volume Sampling and Analytical Considerations

One high-volume sampler was positioned above the hood as shown in Figure 5.2.13.1. The axis of the high-volume sampler was placed nearly horizontally over the front of the hood car; the distance from the top of the hood to the sampler was approximately 10 feet. This zone, being close to the source, is highly turbulent immediately after pushing occurs. This turbulence is due largely to vortex flow caused by the high heat flux of the coke-push plume. In addition to vortex flow, convective turbulence caused by cold air entrainment is taking place. By observation, this turbulent area likely causes the push emissions to be well-distributed and well-mixed in this region. Isokinetic sampling is impossible to attain in such a flow situation. Because of hood movement from oven to oven, use of additional high-volume samplers poses serious operational difficulties.

By placing the high-volume air sampler in a position that is invariant relative to the hood, the fugitive emissions measurement technique yields ratios of reproducible (precise and not necessarily accurate) fume concentrations above the hood (see Section 5.2.13.2). These ratios provide a measure of the hood capture efficiency as it varies with the greenness of the push. In such a location, the time-integrated concentration provides a measure of the plume's concentration throughout a push of given greenness at the point where the sampler is placed. While somewhat wide fluctuations in concentration were found for samples acquired from a set of pushes having a given greenness, averaging by the use of linear regression (as distinguished from arithmetic averaging over all greennesses by "lumping" all data) over the range of push greenness provides a good estimate of an index of relative plume concentration. This estimate can then be used for subsequent approximations of hood capture efficiencies.

Once the fugitive particulate was collected by the sampler, the filter incremental weight and total volume of air sampled (determined from a calibrated flowrate — see Appendix D — over a measured time period) were used to

calculate the average concentration of particulate in the fugitive emissions plume which passed the hood at a representative location. Temperature corrections were not made in calculating relative concentrations under the assumption that the absolute temperature did not vary appreciably in the turbulent, well-mixed push plume. The photographs of each sampled push provided a qualitative characterization of the push plume to further ensure that only "similar" plumes were compared in the statistical analyses. The push plume was photographed such that a perspective view was available of fugitive emissions from the hood perimeter from two vantage points at right angles to one another. These pictures also clearly display the magnitude of the emissions plume.

In the laboratory, the high-volume filter was dried at 65°C and weighed to determine the amount of filterable particulate collected during the fugitive emissions sampling. Examination of the filters indicated that captured particulate matter was highly embedded in the filter matrix; good particle adhesion was evident.

5.2.13.2 Theoretical Considerations

In any measurement of mass emission rates, it is necessary to extract a sample of the particulate-laden gas which is representative of the time-space average concentration of particulate in the gas passing a representative flux area. A differentially small volume of gas containing a substance of concentration"C(A)" flows through a differentially small, normal area "dA" at a local velocity of "U(A)," a function of position; integrating over the entire area of flow, "A," provides a spatial average estimate of the total mass flowrate of the substance contained in the gas. The following vector integral determines the mass flux through the total area:

$$\frac{dM}{dt} = \iint_A C(A) \left[\vec{U}(A) \cdot d\vec{A}\right] \qquad (1)$$

where:

$\frac{dM}{dt}$ = mass flux rate, lbs/hr

C(A) = local concentration of particulate in the elemental area, dA

$\vec{U}(A) \cdot \vec{dA}$ = the vector scalar product of the local flux velocity vector with the normal component of the elemental area, dA.

In practice, average gas velocity and concentration must be approximated, particularly in a harsh environment where local measurements are impractical or impossible. Further, the flux area, through which mass is transferred, is difficult to measure when the emissions are fugitive in nature and consequently not confined to a duct of known area but rather pass unrestrained into the air. Hence, the following approximation is often used:

$$\frac{dM}{dt} \doteq \bar{C}(A) \left[\vec{U}(A) \cdot \vec{A}\right], \qquad (2)$$

where the "bar" denotes an average value of the variable and the symbol "$\doteq$" denotes an approximation. Over a "large number of similar pushes," (i.e., pushes of the same greenness rating and plume behavior) the bracketed term is approximately constant. Under such an assumption, the mass emission rate is proportional to the average concentration in the plume. If subscripts "1" and "2" denote the off and on condition of the exhaust fan, respectively, then equation (2) can be used to write the following:

$$\frac{dM_1/dt}{dM_2/dt} \doteq \frac{C_1}{C_2} \quad . \qquad (3)$$

Furthermore, for a given push greenness rating, the ratio of average concentrations in the entire plume may be replaced by a ratio of "representative" concentrations which reflect the percentage change in concentration at a fixed location as the hood fan is turned on or off. Now the following two mass balances can be written:

$$\frac{dP_1}{dt} = \frac{dF_1}{dt} + \frac{dI_1}{dt} \quad \text{(fan off)} \tag{4}$$

$$\frac{dP_2}{dt} = \frac{dF_2}{dt} + \frac{dI_2}{dt} \quad \text{(fan on)} \tag{5}$$

where:

$\frac{dP}{dt}$ = source emission rate, lbs/hr

$\frac{dF}{dt}$ = fugitive emission rate, lbs/hr

$\frac{dI}{dt}$ = captured emission rate, lbs/hr

For pushes of the same greenness rating, the source emission rate is somewhat constant. Therefore, the approximation is made that:

$$\frac{dP_1}{dt} = \frac{dP_2}{dt} \tag{6}$$

and, with the hood exhaust fan off, the captured emission rate is essentially zero,

$$\frac{dI_1}{dt} = 0 \ . \tag{7}$$

Therefore, the equations combine to give:

$$\frac{dF_1}{dt} = \frac{dF_2}{dt} + \frac{dI_2}{dt} \tag{8}$$

Equation (8) may be normalized through division by dF_2/dt. After rearranging,

$$\frac{dI_2/dt}{dF_2/dt} = \frac{dF_1/dt}{dF_2/dt} - 1 \ . \tag{9}$$

Using the approximation set forth in equation (3), equation (9) is rewritten,

$$\frac{dI_2/dt}{dF_2/dt} \doteq \frac{\overline{C}_1}{\overline{C}_2} - 1 \ . \tag{10}$$

Now, source sampling in the duct which exhausts the hood provides an integrated sample of the collected emissions captured by the hood during the push whose duration is "T." Denoting the measure of these in-duct emissions, as computed from the source sampling data, by R,

$$R = \int_0^T \left(\frac{dI_2}{dt}\right) dt \quad . \tag{11}$$

Then, equation (10) can be rewritten,

$$\int_0^T \left(\frac{\overline{C}_1}{\overline{C}_2} - 1\right)\left(\frac{dF_2}{dt}\right) dt \doteq R \quad . \tag{12}$$

If C_1 and C_2 are measured averages over time (during the entire push), and are measured at representative, well-mixed locations above the collecting hood, then the integral simplifies to:

$$\left(\frac{\overline{C}_1}{\overline{C}_2} - 1\right) \quad E \doteq R \tag{13}$$

where:

$$E = \int_0^T \left(\frac{dF_2}{dt}\right) dt \tag{14}$$

and E represents an estimate of the actual mass emission rate of fugitive emissions around the hood, emitted over the entire push, with the hood exhaust fan on. Rewriting equation (13),

$$E \doteq \frac{R}{\left(\frac{\overline{C}_1}{\overline{C}_2} - 1\right)} \quad . \tag{15}$$

An estimate of the absolute fugitive mass emission rate from the collection hood can be calculated from the measured particulate emission rate in the duct which exhausts the hood and from the ratio of representative, time-average particulate concentrations above the hood measured during similar pushes with the exhaust fan off and on.

Equation (15) provides a relatively good estimate of the fugitive emissions to the extent that the following assumptions are valid:

1. Plume behavior of fugitive emissions around and above the hood is similar for similar process conditions (i.e., same push greenness).

2. The air sampler is located at a location above the hood such that the concentration measured by the

sampler is proportional to the average plume concentration at that elevation, irrespective of whether the exhaust fan is off or on.

3. The product of the plume cross-sectional area and rise velocity through the planar sampling area is somewhat constant for similar pushes and similar meteorological conditions.

To characterize the weather conditions during the fugitive emissions sampling period, as compared with "normal conditions," meteorologists from Clayton Environmental Consultants studied local climatological records. The data were recorded at Detroit Metropolitan Airport located about 20 miles southwest of the Rouge Plant. Such data are useful in showing that the daily average wind speed and direction observed on test days were representative and not atypical when compared with yearly averages.

The meteorological conditions recorded during the testing at the Ford Motor Company complex in Dearborn, Michigan, were near normal based upon current and historical climatological data. The tests performed on two days in January occurred when wind speeds were above average, with one day having above-average temperatures. The tests performed in February consisted of two days with above-average wind speeds, and one day of well-below-average wind speeds. Temperatures were normal during these dates as were the wind directions. All tests conducted in April were on days with below-average wind speeds and above-average temperatures. For seven days of testing during June, wind speeds were below average. However, for the entire month, the combined average wind speed was near normal. Temperatures were also near normal during this month, as were the wind directions. Average wind speeds for the testing dates during the month of July were slightly below normal. Average temperatures, however, were very close to normal, as were the wind directions.

5.2.13.3 Qualifications

We emphasize that the use of high-volume air sampling to characterize fugitive emissions is a largely unproven technique. It is reasonable to expect variation in the flow terms (i.e., bracketed term in equation (2)) from push to push even under conditions of "constant" push greenness and uniform meteorological conditions due to behavioral differences in plume formation and rise. The extent to which these differences materially effect the approximation made to derive equation (3) is largely unknown and not documented in this study. Therefore, it is emphasized that the derived fugitive mass emission rates and hood capture efficiencies used throughout this report are qualified in this respect. Accordingly, all estimates of total system abatement efficiency and all overall system emission factors are limited with respect to accuracy to the extent that the two estimating techniques for fugitive emissions do not approximate "true" hood capture efficiency.

Although Clayton Environmental Consultants believes the fugitive emissions estimates derived from these methods reasonably approximate actual fugitive emissions and add valuable information concerning emissions from this control system, we recognize that these techniques are unproven and rest on certain unverified assumptions.

6.0 PRESENTATION AND ANALYSIS OF RESULTS

To draw meaningful conclusions from the plethora of data collected during this study, techniques were developed to organize, compile, correlate, and statistically analyze the available information. Methods of compilation and presentation of the data are necessarily diverse due to the variety in quantity and quality of historical data, operating and economic data, process data, and performance data for both the hood capturing device and the scrubber.

6.1 Organization and Compilation

6.1.1 Historical Data

The data contained in the daily operating checks are used to characterize system performance in two ways: 1) to determine whether the control system performance during the source testing period was typical and representative of historical performance, and 2) to determine utility costs throughout the history of the control system. Consequently, the data contained on the daily operating checks were used to compute monthly averages for each of these variables throughout the history of the control system.

Table 6.1.1-1 displays the variation in fan current, water flowrate to the Kinpactor, and calculated air and water horsepower required during the period August, 1973 through August, 1975. This 2-year summary shows that considerable fluctuations occur in the monthly averages for these quantities. These data are useful in validating test results within the context of previous system performance.

The criteria used to judge the representativeness of the process conditions during testing was that the average value of an operating parameter during testing should fall within an interval of $\pm 10\%$ of the long-term average value of that variable.(6) Table 6.1.1-2 also shows that typical process conditions existed with respect to the scrubber sampling. Fan currents between and during coke pushes were +9.4% and +7.2% above the historical measurements, respectively. Kinpactor throat differential pressures between and during coke pushes were +10% and +2.5% above historical record, respectively. Water flowrate to the scrubber and pump pressure were -13% and -7.6% of the historical record, respectively.

To determine the utility consumption throughout the history of the control system and to monitor how this consumption varies with time, the major items contributing to utility costs were determined on an average

monthly basis from the historical data. Fan HP requirements were determined by electrical consumption during both the push cycle and idle cycle for the control system. Since the motor operates at 4160 volts, multiplication of this voltage by fan current read from the strip chart recorder determines electrical consumption. (Additionally, because the motor is three-phase, the factor 1.73 was applied; the power factor was assumed to be 1.0.)

Water pump power consumption was computed from flowrate data as monitored on the flow recorder in the control room and from pump pressure as measured by gauges on the pump outlet. The equation used in computing power requirements for the water pump is as shown:

$$HP = \frac{\text{Pump pressure (ft. water)} \times \text{flowrate (gpm)}}{3960 \times (0.85)},$$

where a pump efficiency of 85 percent has been assumed.

Table 6.1.1-1 summarizes the utility requirements computed by these methods for the major utility consumers - the induced draft fan and the water pumps. By applying weighting factors determined by prolonged observation of the control system and typical operator tendencies at Ford Motor Company, the total utility requirement over the two-year period is computed. By assuming that the idle cycle of the control system comprises approximately 40 minutes of any one push-hour while the push cycle (when the emission control system is energized by placing the coke guide in alignment with the coke oven to be pushed) takes approximately 20 minutes of any push-hour, the total utility requirements are shown in Table 6.1.1-1.

Figure 6.1.1 presents a graphical display of the year-to-date cost information obtained from cost accounting departments. The costs, plotted separately for 1974 and 1975, are useful in indicating whether there is any tendency toward excessive maintenance due to deterioration of the control system from year-to-year. Because the cost data are necessarily limited by cost accounting procedures, this method of presentation and analysis of historical economic data was the only technique that could be devised for this study.

The data contained in maintenance or operational logs are difficult to characterize and display. Except for certain recurring problems, many of the malfunctions documented in these logbooks must be read in their

entirety to appreciate the nature of the downtime caused by the malfunction. However, in an attempt to extract salient information from the logbook entries, a summary table has been constructed which presents the major causes of system downtime. Table 6.1.1-3 displays these data. Under each major source of system downtime are listed the dates during which some downtime was attributed to that particular type of system malfunction. Conclusions can be drawn from such a summary as to either the intermittent or ongoing failure of certain system components. In addition to this type of presentation, direct reading of logbook entries pertaining to the "Smokeless Coke Pushing System" maintenance provides a good overview of the type of malfunctions and the importance of the malfunctions. All entries are presented in Appendix A.

6.1.2 Process and Engineering Data

Appendices G and H, respectively, include the "Daily Log of Fume Hood Performance" and "Scrubber Performance" data sheets (to the extent that they were completed by the on-site engineer-observer). These data, in total, are used to determine overall system performance as it varies throughout time. For those days on which source testing occurred, the data from the engineer-observer's log records are assembled into special tables which summarize the process conditions during each type of test conducted.

Appendix I presents tables that list the pertinent process parameters and their averages as measured during the source tests. These tables summarize the oven numbers, greenness of the push, cross-draft wind velocity, stack gas opacity, and net coal charged to each oven pushed during the course of any given test. The averages of all such pushes included in the test under consideration are also included. These test averages are used as the basic engineering and process data for subsequent correlations presented in Section 7.0.

Also included in these tables are daily averages of the scrubber inlet and outlet dry-bulb and wet-bulb temperatures, scrubber inlet and outlet static pressures, throat pressure drop, water pressure at the scrubber throat, recirculated water flow, and fan motor current. As previously indicated, these latter quantities vary insignificantly through the course of a day's testing. As such, the daily averages are reported as they are obtained from any readings taken by the engineer-observer while he was not participating in hood capture efficiency estimates during a source test.

These tables would have also included net coking time; however, due to a malfunction in the Ford Motor Company

recording device, the time of coal charge for each particular oven was not available. As such, only gross coking time estimates could be made from the times included on the coal charge log sheets, and these are included on the process data summaries.

6.1.3 Scrubber Emissions Data

Tables 6.1.3-1 through 6.1.3-92 present mass emission rates and concentrations for each contaminant measured at the scrubber inlet and/or outlet. These data and the process data presented in Section 6.1.2 are related and presented in Section 7.0.

6.1.4 Fugitive Emissions Data

Tables 6.1.4-1 to 6.1.4-5 present the data used in determining filterable particulate concentrations above the hood. Three different system configurations are included in the data base: 1) no collection hood present above the pushed oven; 2) hood in place but no exhaust from scrubber fan (i.e., fan louvers closed); and 3) hood in place and operating with full exhaust volume. The last two configurations provide the data base used in subsequent correlations (see Section 6.3) for providing the quantitative measure of hood collection efficiency defined in Section 5.2.13. To assist in relating these data to any simultaneous source sampling measurements and to the process data, the dates, push times, and oven numbers are provided. A line of data marked with an asterisk indicates a data point classed as an outlier (see Section 6.3 for methodology).

6.2 Emission and Performance Models

6.2.1 Push Emissions

In order to normalize emissions to process parameters, it is necessary to estimate the emission rate of all coke-pushing emissions whether they emanate from the scrubber stack outlet or from the perimeter of the collection hood. Since relative emission rates of fugitive emissions were measured on a concentration basis, it is necessary to consider mass balances of particulate emitted during a push in an effort to estimate total system abatement efficiency. Figure 6.2.1 schematically depicts all streams which contain pollutants entering and exiting a hypothetical boundary drawn around the control system. Further, a mass balance computed by drawing a hypothetical boundary and considering all streams into and out of the collection hood permits relation of fugitive emissions

to scrubber inlet emissions. Recalling that the only measurements of mass emission rates made directly were at the scrubber outlet and scrubber inlet, it is necessary to compute fugitive mass emission rates using the following mass balances (which do not explicitly account for door leaks).

$$P = F + O + S \quad (1)$$

$$P = F + I \quad (2)$$

where,

P = total pushing emissions from oven, lbs/hr

S = emissions removed by scrubber, lbs/hr

F = fugitive emissions from hood, lbs/hr

I = emissions captured by hood, lbs/hr

O = scrubber outlet emissions, lbs/hr

Now, since hood capture efficiency is defined as:

$$E_H = 1 - F/P \quad (3)$$

if terms are regrouped and it is recognized that,

$$F = P - I \quad (4)$$

then,

$$E_H = I/P. \quad (5)$$

Now, having measured the inlet emission rate to the scrubber (I), the fugitive emission rates from the hood can be computed on a mass emission rate basis if the hood capture efficiency has been estimated by independent measurements.

As indicated in Section 5.2.13, concentration measurements around the hood perimeter were made to estimate hood capture efficiency. These measurements resulted in a linear regression line determined and fitted to the data which provided an estimate of hood capture efficiency as a function of the degree of coke greenness discussed below. Furthermore, employing the same data base, linear regression lines may be computed considering the engineer-observer's visual estimate of hood capture efficiency as

a function of the degree-of-greenness. These two regression lines, the methodologies of which are discussed in Section 6.3, are used in establishing a range of estimate of hood capture efficiency. When this range is used in conjunction with the equation shown above, a range of fugitive mass emission rates can be computed. Since the scrubber efficiency is defined as

$$E_s = 1 - O/I \qquad (6)$$

and total efficiency is defined as

$$E_T = 1 - \frac{O+F}{P}, \qquad (7)$$

substitution yields

$$E_T = E_H E_S \qquad (8)$$

Thus, the total system efficiency is the product of the hood capture efficiency and the scrubber control efficiency. This definition of total efficiency is reasonable in that system abatement is as much dependent upon efficient capture of pushing emissions as it is upon efficient scrubbing. Either efficiency, when low, results in a low system efficiency.

Equation (8) shows clearly the strong influence that the hood capture efficiency, E_H, plays in determining total system abatement efficiency, E_T. For example, in consideration of the relatively high scrubber efficiencies in abating particulate matter, a 50-percent hood capture efficiency translates to an approximate 50-percent total system abatement efficiency. Accordingly, any error in the estimate for hood capture efficiency (see Section 5.2.13) introduces a proportional error in total system abatement efficiency. Therefore, estimates of total system abatement efficiencies are only as accurate as the range of estimates for hood capture efficiencies.

Although the measurements conducted to determine the regression lines for estimating hood capture efficiency were determined for particulate matter, it is assumed in subsequent calculations that the hood capture efficiencies can be applied equivalently to the gaseous contaminants.

The highly turbulent flow patterns above the hood, coupled with relatively low indraft velocities present during pushing at the hood perimeter, render the assumption relatively accurate. The assumption permits calculation of total

abatement efficiency (coupling fugitive emission losses and scrubber losses) for gaseous contaminant removal. This "model" is therefore used implicitly in subsequent tables presented in Section 7.0 which display total system efficiencies for gaseous and particulate contaminants.

6.2.2 Scrubber Performance

While many mechanisms and models have been postulated to account for scrubber efficiency for both particulate and gaseous contaminants, correlation of scrubber efficiency to "contact power" remains one of the most straightforward correlations available.

Theoretical attempts to explain variations in, or even the absolute value of, scrubber efficiency are usually successful and accurate if large amounts of empirical data are available for highly random processes. Correlation of efficiency data is attempted here to lend credibility to the test results and to extrapolate the performance of the system to other conditions.

In contact power correlations,[7] the penetration (or one minus the efficiency ($1-E_s$)) is defined in terms of the number of transfer units, N_t. The relationship is logarithmic as shown in the following equation:

$$N_t = \ln\left(\frac{1}{1 - E_s}\right) . \qquad (1)$$

On a log-log plot of the number of transfer units as a function of contact power, efficiency data can be represented as a straight line having a slope and intercept which is a function of the particular scrubber geometry and contaminant being removed. The contact power is computed for each set of scrubber conditions by summing the contact power put into the scrubber by way of the gas stream and the liquid stream. Contact power derived from the gas stream is given by:

$$P_g = 0.157\ (\Delta p). \qquad (2)$$

The pressure drop, Δp, used in computing the gas contact power is measured across the unit at points where gas velocities are equal. The pressure drop inherently must be a measure of useful work done in the scrubbing process and cannot include pressure changes due to velocity in the gas stream. The contact power derived from the liquid hydraulic nozzles is calculated from:

$$P_L = 0.583\ (P_p)\left(\frac{q_L}{q_G}\right) \qquad (3)$$

where:

P_p = pressure at the nozzles (psig)

q_L/q_G = liquid to gas ratio (gpm/1000 SCFM).

The equation assumes that the residual kinetic energy of the liquid stream after contacting with the gas stream is negligible. This contact power, it is assumed, has totally dissipated into turbulent mechanisms which efficiently extract particles from the gas stream.

Table 6.1.1-2 lists the monthly averages of contact power over the two-year history of the control system, as computed from the data contained in Table 6.1.1-1. While the contact power varies considerably over the two-year history of the system, the monthly average contact powers during the source testing period (June and July, 1975) are relatively close to the overall averages. Therefore, we conclude that efficiencies determined during testing were typical of historical scrubber performance as it can be established throughout the system lifetime.

The utility of contact power correlation rests in a proper set of data which permits a good line to be drawn in a contact power graphical plot. It can be seen from the contact power summaries and the emission data summaries, that the range of values of contact power encountered during the source sampling period of June and July, 1975 are not sufficient to provide a broad enough range of contact power for a good correlation. As such, it is not possible to extrapolate with any degree of accuracy what the performance of the scrubber would be if it was operating in accordance with the design manual specification — a pressure drop of 60 inches of water. While it is possible to assume a slope of the line in the contact power correlation and pass that line through the available data point, the slope of the line is a sensitive function of particle distribution and wetting properties of the particulate being removed. Consequently, contact power correlation is used in this report only to demonstrate that scrubber conditions were typical from the viewpoint of historical performance, if not from design conditions, and to provide a data point which identifies an average scrubber performance of 99.3-percent efficiency with a contact power of 6.6 HP/1000 SCFM for filterable particulate matter according to the nine particulate tests conducted.

6.2.3 System Performance

The following calculational procedure is used in computing the estimates of total system abatement efficiency. From 16 to 24 coke pushes were included in any given particulate test. The characteristics of each push varied depending upon the process parameters. The tables referenced and described in Sections 6.1.2 and 6.1.3 are used to determine average process and engineering data and average emissions data, respectively, for the system abatement efficiency computations.

To obtain an estimated range of hood capture efficiency, it is necessary to estimate average coke push greenness. The engineer-observer's estimate of "average degree-of-greenness" is used as the criterion for determining the overall average greenness. From this measure of overall greenness and from the two regression lines determined from fugitive emission measurements and visual estimates, two estimates of hood capture efficiency can be determined. These hood capture efficiencies establish a range which accordingly determines a range of estimated fugitive emissions and total system efficiencies in accordance with the mass balances. With scrubber inlet particulate test results, fugitive emissions can be calculated as shown above. The sum of fugitive emissions and scrubber inlet emissions comprises an estimate of the total coke-push emissions during the particulate test (see Equation (2) in Section 6.2.1). As a check on this sum, it is noted that the coke-push emissions should be equal to the scrubber inlet emissions divided by the hood efficiency of capture. With measurements of stack emission rates from the particulate test, the total efficiency is computed from the sum of the stack and fugitive emission rates divided by the coke-pushing emission rate.

As a check on this total system efficiency computation, the multiplication of hood capture efficiency and scrubber efficiency should yield this total system efficiency. This procedure is utilized for each of the nine particulate tests and for any other sampling tests where both simultaneous scrubber inlet and outlet emission rates were measured.

For each type of test, then, overall averages of hood capture efficiency, scrubber inlet emissions, fugitive emissions, stack emissions, and total

efficiencies are computed. These overall averages are used in evaluating the performance of the total system in abating pushing emissions. The results obtained are contingent upon the "model" assumptions which include:

1. The engineer-observer's estimate of the degree-of-greenness is sufficient to estimate the hood capture efficiency quantitatively by two independent methods;

2. The regression lines obtained from the fugitive emission measurements and visual emission measurements establish a range of estimated hood capture efficiencies that contains the actual hood capture efficiency;

3. Scrubber inlet and outlet emission rates were simultaneously measured; and

4. The estimate of hood capture efficiency as obtained from particulate matter can be extrapolated to determine overall gaseous contaminant abatement efficiencies.

6.3 Evaluation of Hood Capture Efficiency

Section 5.2.13 discussed the mathematical basis for the method (Method 1) used to estimate hood capture efficiency from high-volume air sampling data. This section discusses the data reduction and correlation procedures used to derive hood capture efficiency estimates from the data base presented in the tables in Appendix I and Tables 6.1.4-1 through 6.1.4-5.

As indicated previously, an engineer-observer was present to accumulate certain process parameters and hood capture efficiency estimates during a large portion of the source testing phase of the program. The estimates by the engineer-observers comprise the largest data base, by far, from which visual hood capture efficiencies can be deduced. In addition, however, it was necessary to obtain some measure of the fugitive emissions, in accordance with previously mentioned procedures, to provide a quantitative estimate of the hood capture efficiency. To relate these emissions measurements to the degree of coke push greenness, photographs were taken at the beginning, middle, and end of the coke pushes. In addition, a fugitive emissions observer rated the particular coke push. The engineer-observer provided a second, independent

observation of the coke push greenness. Supplementing these judgments of coke push conditions, Ford Motor Company personnel also routinely record whether each coke push is "green" or "clean" as it emerges from the oven.

The photographs were rated independently by two analysts, each grading a coke push as "clean," "medium," or "green." Thus, five independent estimates of the degree of coke push greenness were obtained. These "degrees-of-greenness" were rated as 1, 2, and 3, corresponding respectively to "clean," "medium," and "green."

During the analysis of these five independent observations, considerable disagreement was noted among the observers. In order to determine whether any one observer was biased, each observer's readings were compared statistically to the average of all other observers' readings using the non-parametric "Sign test."[8] The only observer found to be biased was the Ford Motor Company observer. Although comparison of the Ford observer with the engineer-observer was possible over a large data base (that is, the entire several months of data available from Ford records and engineer-log records), there was no reason to believe that the engineer-observer was not also biased. Therefore, the bias test was conducted only using a data base where a minimum of three other observers could be averaged in an attempt to determine bias of any fourth observer. As a result, all Ford observer readings were excluded from subsequent analyses.

The next step in the determination of hood capture efficiencies was the averaging of the non-biased observers' readings to determine an average greenness for each push that was characterized by filtration measurements and photography. In order to correlate the suspended dust concentration measured above the hood with average greenness value, three operational codes were established and defined as follows:

Code 1 - Hood not in place and exhaust fan not running

Code 2 - Hood in place and exhaust fan not running

Code 3 - Hood in place and exhaust fan running.

For each of these individual codes, the logarithms of concentrations obtained by filtration were correlated with the average greenness computed from the four unbiased observers' estimates. The regression lines were plotted on semi-log paper and 95-percent confidence intervals were established. Any data points outside the 95-percent confidence interval and any data points associated

with photographs deemed atypical (in the sense that the plume appeared to pass the high-volume air sampler in such a way as to not be sampled representatively) by two or more independent analysts, were excluded from the data base for that particular code. New regression lines were then computed using the revised data base. Figures 6.3-1 to 6.3-3 display the semi-log regression estimates of concentrations above the hood as a function of average greenness for the three system configurations. Those data points deemed to be "outliers" according to the aforementioned criteria are so indicated in Tables 6.1.4-1 to 6.1.4-5 which list the pertinent parameters comprising fugitive emissions data.

An initial analysis of variance indicated that the Code 1 and Code 2 fugitive emissions data might not be significantly different from one another. The Code 3 data, however, was found to have a mean value that was significantly different from the other two sets. Thus, when the regression lines were constructed the lines for Code 1 and Code 2 were tested for homogeneity. Only the test for homogeneity of variances was completed. Since the residual variances were found to differ significantly, no further testing was required and the two lines were considered unique. The analogous computation was not carried out using the Code 3 line because of the results of the analysis of variance and the differences apparent upon visual inspection of the plots.

As indicated in Section 5.2.13, the basic difference between concentrations measured above the hood for Codes 1 and 2 rests in the contribution of the hood in dispersing fugitive emissions and providing a more diffuse plume. Therefore, based upon the above tests, the regression lines obtained for Codes 1 and 2 were considered distinguishable, indicating that the fugitive emissions measurement technique is sensitive enough to discern the effect of the non-exhausted hood on fugitive plume concentrations of filterable particulate. Therefore, the data of Codes 1 and 2 were not combined.

To provide a more meaningful estimate of hood capture efficiency, hood capture efficiency was defined as (see Equation (3) in Section 6.2.1):

$$E_H = 1 - \frac{\text{concentration for Code 3}}{\text{concentration for Code 2}}.$$

The concentration measured during a Code 2 push (for a given greenness rating) is considered to reflect the total loss of all push emissions since the exhaust

fan is off. Using this definition, Figure 6.3-4 displays the variations in estimated hood capture efficiency calculated from Codes 2 and 3 as a function of average coke push greenness.

To obtain a second estimate of hood capture efficiency, regression analysis was used to relate the hood capture efficiency visually estimated by the engineer-observer to average greenness. The average greenness used in this correlation was the same average greenness used in the previous correlation, and the estimated hood capture efficiency was that obtained directly from the hood capture data sheets (Appendix G). This estimate of capture efficiency was used in an attempt to fit a regression line which relates estimated efficiency as a direct function of average greenness. The results of this regression analysis are also shown in Figure 6.3-4.

These two techniques provide a range of estimated hood capture efficiencies established by two independent calculational methods using an identical data base. They provide the best estimate available as a result of this study to define a range in estimated hood capture efficiency and estimated total emissions and estimated total system abatement efficiencies. As indicated in Section 6.2.1, the total system abatement efficiency, determined from hood capture efficiency and scrubber removal efficiency, is limited in accuracy to the extent that the hood capture efficiency is incorrectly depicted by the two fugitive emissions estimates. This qualification applies as well to all computed total and fugitive emission factors. Nevertheless, although the fugitive emissions estimates are based upon methods that are largely unproven (see Section 5.2.13), we believe the capture efficiencies predicted by the two regressions to be reasonable approximations of actual hood performance.

6.4 Emission and Process/Control System Correlations

It is useful and informative to devise predictive or correlative models that relate pushing emissions to process or control system parameters. If highly-significant correlations are obtained, the results can be used, within limitations, to extend findings in this study to other coke batteries that contemplate application of the same or similar control systems.

Based upon experience and subjective considerations, it is informative to examine the following relationships:

1. Control device stack gas opacity as a function of greenness rating of the push;

2. Filterable particulate pushing emission rate as a function of the average greenness rating;

3. Particulate size distribution of pushing emissions as a function of average greenness rating;

4. Hood capture efficiency as a function of average greenness rating;

5. Total system abatement efficiency as a function of average greenness rating;

6. Filterable particulate pushing emission rate as a function of the ratio of number of green pushes to number of clean pushes;

7. Greenness rating of the push as a function of net coking time;

8. Greenness rating of the push as a function of coking temperature;

9. Particulate size distribution of pushing emissions as a function of the organic material content of the particulate;

10. Hood capture efficiency as a function of ambient wind velocity;

11. Filterable particulate pushing emission rate (measured in a multi-push particulate test) as a function of average net coking time; and

12. Filterable particulate emission rate as a function of oven temperature.

Some of these correlations have been attempted in this study. However, several could not be attempted for various reasons. The "printer-clock" at the Ford "A" and "B" Battery control room, which automatically records the net coal charged and the charge time, was malfunctioning for several months. Although the net coal charge weights were recorded, the charge times were not. Consequently, the gross coking time (i.e., push-to-push time for a given oven), rather than net coking time, is the only parameter available for correlations based upon this independent variable.

The particle sizing method used, the Andersen impactor, provided too little particulate matter for determination of organic materials content. Consequently, the ninth correlation listed could not be attempted. The results of all other correlations are included. Section 7.0

presents those results which relate to system performance, including hood capture efficiencies and scrubber efficiencies for specific materials.

It should be noted that correlations deemed "significant" herein based upon their respective correlation coefficient do not indicate a cause-and-effect relationship; they only imply that some relationship exists. In actuality, a third factor may be affecting both of the other two factors and causing the apparent correlation.

Average scrubber outlet stack gas opacity correlates well with average greenness rating when the nine multi-push particulate tests are used. The correlation coefficient is 0.843, significant at the 99-percent level.

The filterable particulate pushing emission rates (i.e., fugitive emissions plus those captured by the hood) apparently correlate well with the average greenness ratings. The two methods of calculating pushing emission rates provide two separate estimates of the relationship. For Method 1 (see Section 6.2.1), the correlation coefficient is 0.819, significant at the 99-percent level. Using Method 2 to estimate hood capture efficiency, the correlation coefficient is 0.859, also significant at the 99-percent level.

The inlet particle size data provide useful information required to design and assess the control device used to abate collected emissions. As such, correlations were attempted to relate an index of the inlet particle distribution to the average greenness rating of pushes that comprised each test. It was found that, for 19 data sets, the percentage of inlet particles on a mass basis less than one micron in diameter are not correlated significantly with greenness. However, the inlet percentages of particles, on a mass basis, less than five microns and less than 10 microns were correlated significantly with greenness (at the 95-percent confidence level) as evidenced by their respective correlation coefficients of 0.462 and 0.518. Each correlation used the inlet particle size data sets listed in Table 7.3.1-15.

The correlation between hood capture efficiency and average greenness rating has been presented previously in Section 6.3. The results have been plotted in Figure 6.3-4.

Total system abatement efficiency apparently correlates well with average greenness rating for filterable particulate matter. Total system efficiency is the product of hood capture efficiency and scrubber efficiency (see Section 6.2.1 and Equation (8) in Section 6.2.1). Using

Method 1 to estimate hood capture efficiency, the correlation coefficient is -0.998, significant at the 99-percent level. Using Method 2 to estimate hood capture efficiency, the correlation coefficient is -0.999, significant at the 99-percent level.

An apparently significant correlation was found between the filterable particulate emission rate (measured in a multi-push particulate test) and the ratio of the number of green-to-clean pushes constituting the test. Again, two results were obtained, depending upon which method was used to estimate hood capture efficiency. Using Method 1, the correlation coefficient is 0.876, significant at the 99-percent level. Using Method 2, the correlation coefficient is 0.912 which is significant at the 99-percent level.

An apparently significant correlation was found between the greenness estimate for a given push (documented by the engineer-observer) and the gross coking time. The data, consisting of 320 pairs of greenness ratings and gross coking times, exhibit a correlation coefficient of -0.157, significant at the 99-percent level.

An apparently significant correlation was also found between greenness rating and oven temperature (recorded once each shift; see Section 5.1.5). The correlation coefficient for the 164 data pairs obtained during the nine particulate tests is -0.374, significant at the 99-percent level.

An apparently significant correlation was also found between greenness rating and the product of gross coking time and oven temperature. The correlation coefficient for the 207 sets of data is 0.331, significant at the 99-percent level.

No apparent linear correlation was found between hood capture efficiency and wind velocity as measured and documented by the on-site observer. The measure of hood capture efficiency used in this attempted correlation was that recorded by the engineer-observer from his visual estimate (i.e., Method 2). These data are presented in Appendix G.

No apparent linear correlation exists between the filterable particulate push emissions measured in the nine particulate tests (and expressed as pounds per ton of coal charged) and average gross coking time. The correlation coefficients of -0.502 and -0.505 for Methods 1 and 2, respectively, (see Section 6.3), are not significant. This is likely attributable to the use of gross coking

time, rather than net coking time, as the independent variable. Furthermore, because the particulate tests were necessarily multi-push tests, the identity of the emissions from an individual push is "diluted" by the others. This is further complicated by the narrow range in gross coking time, 940 to 1053 minutes.

No apparent linear correlation exists between the filterable particulate emission factors and the average oven temperature for the ovens pushed during each of the nine multi-push particulate tests. The correlation coefficients of 0.320 and 0.349 for Methods 1 and 2, respectively, are not significant. Again, because the particulate tests were necessarily multi-push tests, the identity of the emissions from an individual push is "diluted" by the others. Furthermore, oven temperatures are recorded only once per shift.

We emphasize that the correlations presented above are based upon limited data. While the results obtained are significant statistically, the extent to which process emissions are predictable by considering only single independent variable correlations is open to question. The basis used in prescribing the variable to be correlated and the mathematical form of the correlation is largely intuitive and is based upon our experience in other coke oven emission studies. It is possible that multiple regression type correlations may reveal statistically significant relationships if the independent variables are judiciously chosen from the available data base. Attempts at such correlations are recommended and the requisite data are available in the aforementioned appendices of this report.

7.0 SUMMARY OF FINDINGS

This section presents an evaluation by Clayton Environmental Consultants, Inc. of the Ford/Koppers coke-pushing emission control system based upon:

1. Overall control system performance and reliability;
2. Estimated capture efficiency of the exhaust hood device during coke pushing; and
3. Scrubber abatement efficiencies for both gaseous and particulate contaminants.

The process data and emission measurements for each test are summarized in detail in Section 6.0. Tables 7.0-1 through 7.0-14 relate these two types of measurements and present: 1) contaminant emissions measured at the inlet and outlet of the scrubber, 2) scrubber control efficiency, 3) estimated hood capture efficiency (as determined by each of two methods), 4) fugitive emissions as estimated from hood capture efficiency, 5) total estimated pushing emissions (computed from the sum of inlet emission to the control system and the hood fugitive emissions), and 6) estimated overall control system efficiency (based upon the two methods of estimation of hood capture efficiency).

Although the accuracy of the hood capture efficiency cannot be established using "proven" techniques, the precision of the statistically estimated capture efficiencies (by regression techniques) is good. For the set of nine multi-push particulate tests, the mean estimate of hood capture efficiency by Method 1 is 41 percent ($\pm$ 5 percent)*; the mean estimate by Method 2 (visual judgment) is 66 percent ($\pm$ 9 percent)*.

Despite the precision of each method, the range of capture efficiencies defined by Method 1 and Method 2 suggests that the emission factors presented in Tables 7.0-1 through 7.0-14 need to be qualified as estimates that have not been verified by independent measurement.

Some of the contaminants listed in Table 3.2-2 are excluded from scrubber efficiency and mass emission rate analysis because their measured values were found to be consistently below the limits of detectability.

Accordingly, the contaminants presented in Tables 7.0-1 through 7.0-14 include: filterable particulate and condensibles, the chloroform-ether soluble fraction of filterable particulate and condensibles, sulfur dioxide, sulfur trioxide, sulfur oxides (as sulfates), carbon monoxide, nitrogen oxides (as NO_2), benzene, benzene and homologues, total light hydrocarbons (as methane), methane and homologues, and ethylene and homologues.

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* The notations ($\pm$ 5 percent) and ($\pm$ 9 percent) are estimates of the precision of the mean values based upon a 95-percent level of confidence.

Conversion factors to enable computation of emission factors in terms of dry coal charged are presented in Section 1.2 of this report.

7.1 Overall System Performance

Generally, the aspect of system performance which most directly determines and affects the system evaluation is the ability of the hood and scrubber to capture and remove emissions. In addition to efficiency, certain operating characteristics must be considered in this evaluation to determine the frequency with which the abatement system performed as intended.

Ideally, records of the number of times the emission control system came to the full operation condition would indicate the percentage of the time that the emission control system functioned properly. Unfortunately, charts in the control room which record fan amperage (and therefore the degree of system operability) were not saved and, therefore, could not be researched to determine long-term operability by this method. However, during the months of June and July, 1975, the engineer-observer and the test crew present during the day shift recorded the number of times the system functioned at full operating potential. Various malfunctions, which included the failure of the Rayco cylinder to open completely the fume main doors and thereby actuate the inlet fan louvers, consistently contributed to the temporary failures of the system. Table 6.1.1-3, as previously presented, lists those failures considered to be chronic.

Any assessment of the emission control system which considers total abatement efficiency must also include the fraction of the time for which the system functioned according to design. During those days when Clayton observers were on-site near the end of June, 1975, approximately half of the pushes during the day shifts resulted in totally uncontrolled emissions. System observation during other parts of June and during the month of July, 1975, indicated that the system performed nearly 80 percent of the time to abate pushing emissions consistent with control efficiency estimates presented in Tables 7.0-1 through 7.0-14.

The "downtime" observed during this period was unusual based on the system observation conducted intermittently during the previous year. The chronic failure of the Rayco cylinder caused the main fan louvers to not open, leaving the control system in idle mode during many pushes. Once the cause was found and corrected, the system returned to its normal operability. Table 6.1.1-3 shows clearly that this unusual period of chronic failure does not necessarily represent a gradual degradation of operability or availability.

During other months of 1974 and 1975, visual observations were made by the engineer-observer during the day shift to characterize the hood capture efficiency and stack opacity and summarize, in general, the system operability. No conclusions can be made about the percentage of pushes controlled to any degree during the second and third shifts because the Ford Motor Company maintenance records indicate that repair of malfunctions was often scheduled for daytime maintenance crews. However, frequent difficulty in diagnosing basic causes for system component failure caused the system to fail consistently during some periods.

Any attempt to cite a representative percentage of time for which the emission control system was down is necessarily biased by the nature of the malfunction occurring while the engineer-observer was on-site. However, such observations indicate that the system performed approximately 80 percent of the time in abating pushing emissions. This conclusion is based upon system observations during the months of August and September of 1974, intermittent observations during January, February, and April of 1975, and continuous observation during June, July, and portions of August and September of 1975. Thus, a total, overall system performance evaluation should include multiplication of total abatement efficiencies by 0.8 to account for the 20-percent downtime estimated by Clayton observation.

7.2 Hood Capture Efficiency

As previously indicated, Figure 6.3-4 displays the hood capture efficiency estimated by two different methods. This figure indicates that for a push with an average greenness of 1.0 (clean push), the estimated hood capture efficiency ranges between 54 and 92 percent. Similarly, a push exhibiting an average greenness of 2.0 results in a hood capture efficiency estimated to range between 38 and 61 percent. A push which exhibits an average greenness of 3.0 (green push) leads to a hood capture efficiency estimated to range between 22 and 30 percent. Because several coke pushes were included in some of the particulate and gaseous contaminant tests, it was necessary to resort to two-significant-figure accuracy to compute average coke-pushing greenness. Interpolation was used in Figure 6.3-4 to provide a range of hood capture efficiencies.

The results reported in this section are for those contaminants which exhibited concentrations which were greater than the limit of detectability. Of the other contaminants listed in Table 3.2-2, the following were not included in Tables 7.0-1 through 7.0-14 because values reported were all below the limit of detectability: acetylene, acridine, acrolein, ammonia, anthracene, benzo(a+e)pyrene, carbazole, carbon disulfide, chlorine, chrysene, cyanide, fluoranthene, fluorene, 9-fluorenone, hydrogen sulfide, naphthalene, phenanthrene, pyrene, pyridine, total

phenolics, and total reduced sulfur. The process conditions existing during tests for these compounds and the calculated mass emission rates are expressed in the data listed in Appendix I and Tables 6.1.3-1 through 6.1.3-92, respectively. The accuracy of these emission factors is contingent upon the accuracy of the estimated fugitive emissions.

As indicated, emission factors are presented, in this section, in English dimensional units as this system is most widely used in the coking industry.

7.2.1 Particulate Matter

During the nine particulate tests, average greenness ratings ranged from 1.4 to 2.4, with an arithmetic mean of 1.8. Hood capture efficiencies, as estimated by fugitive emission concentration measurements (Method 1), during these nine tests ranged from 32 to 48 and averaged 41 percent. For these same nine particulate tests, the hood capture efficiency estimated from the engineer-observer's visual observations (Method 2) ranged from 49 to 80 percent with an average of 66 percent. Therefore, as shown in Table 7.0-1, it can be concluded that the hood captures between 41 and 66 percent of all filterable particulate coke-pushing emissions, assuming the nine particulate tests are characteristic of coke-pushing emissions normally produced at Batteries A and AX. For these ranges of greenness ratings and hood capture efficiencies, fugitive filterable particulate emissions, expressed as "pounds per ton of coal charged," ranged from 1.07 to 2.55 and averaged 1.70 as estimated by Method 1; and from 0.246 to 1.25 with an average of 0.629 as estimated by Method 2. Similarly, for the same set of nine particulate tests, fugitive condensible emissions ranged from 0.0101 to 0.0982 and averaged 0.0508 as estimated by Method 1; and from 0.0023 to 0.0481 with an average of 0.0199 as estimated by Method 2 (see Table 7.0-2).

In an attempt to determine the organic fraction of filterable and total particulate emissions, analytical procedures were employed which use chloroform-ether extraction techniques (see Section 5.2.1). The materials soluble in chloroform-ether are thus defined in this study as organic constituents of the sampled particulate. Tables 7.0-3 and 7.0-4 display, respectively, the filterable and condensible chloroform-ether soluble particulate emissions and control efficiencies. Because the same samples were analyzed for these "organic" constituents as those analyzed and reported in Tables 7.0-1 and 7.0-2, the greenness ratings and hood capture efficiencies are identical. Fugitive emissions of chloroform-ether soluble, filterable particulate, based on Method 1, ranged

from 0.0023 to 0.0536 and averaged 0.0211 pound per ton of coal charged (see Table 7.0-3). These same emissions estimated by Method 2 ranged from 0.0005 to 0.0244 and averaged 0.0084 pound per ton of coal charged. Fugitive chloroform-ether soluble, condensible emissions ranged from <0.0005 to 0.0100 and averaged 0.0046 to 0.0047 pound per ton of coal charged as estimated by Method 1; and from <0.0002 to 0.0049 with an average of 0.0017 pound per ton of coal charged as estimated by Method 2 (see Table 7.0-4).

7.2.2 Sulfur Oxides

Tests designed to measure sulfur dioxide and sulfur trioxide indicated hood capture efficiencies computed by Method 1 ranging from 22 to 43 with an average of 38 percent. For the coke pushes tested, averaged greenness ratings ranged from 1.7 to 3.0 with a mean of 2.0. Correspondingly, the average hood capture efficiency estimated by Method 2 ranged from 30 to 71 with a mean of 61 percent. The emission control system thus captures bewteen 38 and 61 percent of all sulfur dioxide (see Table 7.0-5) and sulfur trioxide emissions (see Table 7.0-6), assuming that the coke pushing emissions during this series of tests are typical of those emitted over long periods of time. The average hood capture efficiencies for sulfur dioxide and sulfur trioxide are assumed to be identical for each test because these contaminants are determined by analysis of samples from the same impinger contents. However, fugitive emissions of sulfur dioxide are substantially different from sulfur trioxide because they are based upon the total mass of each species emitted.

The fugitive sulfur dioxide emissions expressed as pounds of sulfur dioxide per ton of coal charged ranged from 0.0095 to 0.0418 and averaged 0.0166 as determined by Method 1. Similarly, sulfur dioxide emissions ranged from 0.0029 to 0.0275 and averaged 0.0077 as determined by Method 2.

Fugitive sulfur trioxide emissions expressed as pounds of sulfur trioxide per ton of coal charged ranged from less than 0.00057 to 0.014 and averaged 0.0019 to 0.0030 as determined by Method 1. Similarly, sulfur trioxide emissions based on Method 2 ranged from less than 0.00018 to 0.0056 and averaged 0.0007 to 0.0013.

Total sulfur oxides measured as "sulfate" are tabulated in Table 7.0-7. For the pushes tabulated, the hood capture efficiency ranged from 22 to 54 percent with an average of 36 percent using Method 1. Method 2 yielded

hood capture efficiencies ranging from 30 to 92 with an average of 58 percent. Therefore, the hood capture efficiency (see Table 7.0-7) ranged from 36 to 58 percent assuming that the pushes sampled produced typical sulfur oxide emissions. Fugitive emissions of sulfur oxides expressed as pounds of sulfate per ton of coal charged ranged from 0.0354 to 0.465 and averaged 0.176 using Method 1. Similarly, fugitive sulfur oxides emissions ranged from 0.0036 to 0.220 with an average of 0.089 using Method 2. These six tests included pushes which exhibited average greenness ratings ranging from 1.0 to 3.0 with a mean of 2.1.

7.2.3 Carbon Monoxide

For the six carbon monoxide tests included in the summary (see Table 7.0-8), the hood capture efficiency ranged from 22 to 54 percent with an average of 44 percent using Method 1. Using Method 2, the efficiency ranged from 30 to 92 and averaged 73 percent. The average greenness ratings during these six grab-sample tests ranged from 1 to 3 with a mean of 1.6. Fugitive emissions of carbon monoxide expressed as pounds of carbon monoxide per ton of coal charged for Method 1 ranged from less than 0.0027 to 0.074 with an average of 0.032 to 0.033. Uncaptured emissions of carbon monoxide based upon Method 2, ranged from less than 0.00028 to 0.049 with an average of 0.015.

7.2.4 Oxides of Nitrogen

Hood capture efficiencies for the 13 nitrogen oxides tests ranged from 22 to 54 with an average of 44 percent using Method 1. Similarly, the capture efficiencies for nitrogen oxides using Method 2 ranged from 30 to 92 and averaged 73 percent. These estimates are based on the average greenness ratings for these same 13 tests ranging from 1 to 3 with a mean of 1.6. The hood capture efficiencies thus ranged from 44 to 73 percent assuming that these 13 pushes are typical of the nitrogen oxides emissions. Fugitive emissions of nitrogen oxides expressed as pounds of nitrogen oxides per ton of coal charged range from less than 0.0014 to 0.0603 with an average of 0.011 using Method 1. Uncaptured emissions of nitrogen oxides using Method 2 ranged from less than 0.00015 to 0.0397 and averaged 0.0057 pounds per ton of coal charged (see Table 7.0-9).

7.2.5 Benzene and Homologues

Based upon the six test results for benzene emissions displayed in Table 7.0-10, the hood capture efficiency using Method 1 ranged from 22 to 43 and averaged 33 percent. The average greenness ratings for these six tests

ranged from 1.7 to 3 and averaged 2.3. Similarly, hood capture efficiencies using Method 2 ranged from 30 to 71 with an average of 51 percent. Fugitive emissions of benzene using Method 1 expressed as pounds of benzene per ton of coal charged ranged from less than 0.0001 to 0.007 with an average of 0.002. Fugitive emissions based on Method 2 ranged from less than 0.00003 to 0.005 with an average of 0.001 pound per ton of coal charged. Four of the six tests reported less-than values. These data indicate that these uncaptured emission estimates must be considered approximate.

Laboratory tests conducted for benzene and homologues emissions are based upon analytical measurements made from the same charcoal tubes from which benzene analytical results were obtained. Average greenness ratings and hood capture efficiencies are the same as those reported for benzene emissions. Fugitive emissions based upon Method 1 expressed as pounds of benzene and homologues per ton of coal charged range from 0.0010 to 0.132 and average 0.025. The fugitive emissions based on Method 2 range from 0.00032 to 0.0868 and average 0.016. None of the values for benzene and homologues reported for these six tests were less-than values (see Table 7.0-11).

7.2.6 Total Light Hydrocarbons

Average greenness ratings for the grab-sample tests for total light hydrocarbons (as methane) ranged from 1 to 3 with a mean of 1.5. Hood capture efficiency for total light hydrocarbons based upon Method 1 ranged from 22 to 54 with an average of 46 percent. Hood capture efficiencies based upon Method 2 ranged from 30 to 92 and averaged 76 percent. Fugitive emissions for total light hydrocarbons expressed as pounds of total light hydrocarbons per ton of coal charged based upon Method 1 ranged from 0.0005 to 0.0825 with an average of 0.017. Fugitive emissions based on Method 2 ranged from 0.00005 to 0.00842 and averaged 0.0026. None of the values reported for the six tests for total light hydrocarbons are less-than values (see Table 7.0-12).

7.2.7 Methane and Homologues

Methane and homologues emissions (see Table 7.0-13) were obtained from the same samples as were the results for total light hydrocarbons. The average greenness ratings and hood capture efficiencies are the same as those delineated above for total light hydrocarbons. Fugitive emissions based on Method 1 expressed as pounds

of methane and homologues per ton of coal charged ranged from 0.0003 to 0.003 and averaged 0.001. The fugitive emissions ranged from 0.00003 to 0.0009 and averaged 0.0003 based on Method 2.

7.2.8 Ethylene and Homologues

The samples analyzed for ethylene and homologues were those used for the methane and homologues and the total light hydrocarbon tests. Average greenness ratings and hood capture efficiencies are the same as those delineated above for total light hydrocarbons. Fugitive emissions based on Method 1 expressed as pounds of ethylene and homologues per ton of coal charged ranged from less than 0.0002 to 0.0516 and averaged 0.010. Fugitive emissions based on Method 2 ranged from less than 0.00002 to 0.00527 and averaged 0.001. The values of ethylene and homologues reported for two of the six tests were less-than values (see Table 7.0-14).

In summary, hood capture efficiencies as determined by the two methods ranged on the average between 33 and 46 percent as measured by Method 1, and between 51 and 76 percent as measured by Method 2 for the series of tests conducted for each of the contaminants mentioned above. General indications are that for the types of pushes sampled during the June and July test periods, the hood capture efficiencies averaged approximately 50 percent or slightly greater. These efficiencies are contingent upon the types of pushes encountered during the test period (see Section 8.3).

Clayton Environmental Consultants believes that the reported ranges of emission factors (determined by Methods 1 and 2 for estimating fugitive emissions) include a useful estimate of pushing emission factors for each species tested. Nevertheless, we emphasize that the emission factors include a non-standard technique for estimating fugitive emissions and, as such, must be qualified as being limited in accuracy by the accuracy of the methods.

7.3 Scrubber and Total System Efficiencies

Tables 7.0-1 through 7.0-14, as indicated previously, tabulate mass emission rates into the collection system, fugitive emission rates, and stack emission rates. From these, total pushing emissions are estimated. Average hood capture efficiencies and scrubber efficiencies are calculated; the total system abatement efficiency is the product of these two efficiencies. The previous section provided estimates of hood capture efficiencies for each of the species tested for which some concentrations were greater than the limit of detectability. This

section lists measured scrubber efficiencies and estimated total system efficiencies for each of these species.

As indicated, emission factors presented in this section utilize the English system of dimensional units since this system is most widely used in the coking industry.

7.3.1 Particulate Matter

For the nine particulate tests conducted, average greenness ratings ranged from 1.4 to 2.4 with a mean of 1.8. For these tests, the scrubber efficiency ranged from 99.1 to 99.6 and averaged 99.3 percent for filterable particulate; for condensibles, scrubber efficiency ranged from zero to 90.5 and averaged 47.7 percent. The resultant estimated overall system control efficiency for filterable particulate ranged from 32 to 48 and averaged 41 percent based on Method 1; total system abatement efficiency for condensibles based upon Method 1 ranged from zero to 39 and averaged 20 percent. The resultant estimated overall system control efficiency for filterable particulate emissions based upon Method 2 ranged from 49 to 80 and averaged 66 percent; total system efficiency for condensibles based on Method 2 are estimated to range from zero to 64 and average 33 percent. The estimated overall system abatement efficiency for filterable particulate emissions averaged between 41 and 66 percent based upon the two methods used to estimate hood capture efficiency.

If filterable "organic" particulate matter is defined as the chloroform-ether soluble fraction of filterable particulate, then scrubber efficiency for chloroform-ether soluble filterable particulate ranges from 52.6 to greater than 98.4 and averages 87.2 percent, while estimated total system abatement efficiency for this material ranges from 35 to 58 percent.

Particle sizing test results are summarized in Tables 7.3.1-1 through 7.3.1-14. The results are plotted on log-normal probability paper in Figures 7.3.1-1 and 7.3.1-2 for the inlet and outlet, respectively. For each set of lines, a line is constructed which averages the seven tests. The average distribution is obtained by averaging the weight percentages obtained from each impactor stage for each set of inlet and outlet tests. The differences among the individual size distributions displayed in Figures 7.3.1-1 and 7.3.1-2 are likely attributable to variations in both process conditions and sampling technique. The average line shows that the particle size distribution measured at the inlet displays a mean particle size diameter greater than 10 microns.

At the outlet, the mean particle size diameter is approximately 1.7 microns; the geometric standard deviation of the outlet distribution is 4.7. All particle size tests were conducted with the Andersen impactor.

The concentration of filterable particulate matter at the scrubber inlet and outlet has also been computed from the Andersen particle size samples. The results are displayed in Table 7.3.1-15. The ranges in calculated concentrations result from the use of "less than" values as equal to zero or equal to the less than value. At the scrubber inlet, filterable particulate data (Table 6.1.3-65 indicate concentrations ranging from 1.46 to 1.91 grains per dry standard cubic foot (gr/DSCF). Table 7.3.1-15 indicates that inlet concentrations obtained from Andersen sampler data range from 0.551 to 1.34 gr/DSCF. At the scrubber outlet, filterable particulate concentrations ranged from 0.006 to 0.015 gr/DSCF (Table 6.1.3-66 . The Andersen sampler data indicate outlet concentrations ranging from less than 0.002 to 0.042 gr/DSCF as shown in Table 7.3.1-15. These results compare well considering that particulate emission tests and particle sizing tests were not conducted for the same set of pushes. The inlet Andersen data in Table 7.3.1-15 are computed from samples collected over a short time due to the high loading of particulate at that location. The outlet data are based upon samples collected over much longer periods. In most cases three inlet samples are taken for each corresponding outlet sample to provide a semblance of simultaneous testing. Test times are displayed in the table.

Tables 7.3.1-16 and 7.3.1-17 list the components of the particulate matter collected in the nine inlet and outlet particulate tests, respectively. The percentages of sulfate, iron, aluminum, titanium, and chloride are given.

7.3.2 Sulfur Oxides

Scrubber control efficiencies for sulfur dioxide ranged from nil to 63 and averaged 42 percent. Total system abatement efficiency based upon both estimates of hood capture efficiency ranged from nil to 45 percent. The average total system abatement efficiency for sulfur dioxide push emissions is estimated to range from 16 to 26 percent.

The average greenness of the nine sulfur rioxide tests ranged from 1.7 to 3.0 and averaged 2.0. Sulfur trioxide scrubber efficiencies ranged from nil to greater than 91 percent and averaged from 39 to 67 percent (depending upon the method of computation of the average). The

resultant total system abatement efficiency for sulfur trioxide based upon the Method 1 estimation of average hood capture efficiency ranged from 9 to 42 percent and averaged 15 to 27 percent. The total system abatement efficiency based upon Method 2 is estimated to range from 19 to 71 and average 25 to 44 percent. Only three of the nine tests permitted meaningful computation of scrubber efficiencies. Therefore, the broad range of total system abatement efficiencies must be considered approximate. These conclusions are largely dependent upon the low concentrations of sulfur trioxide measured at the inlet location. For the nine tests conducted, six tests consistently exhibited less-than values (that is, below the limit of detectability) for sulfur trioxide.

For the six sulfur oxides tests conducted, the average greenness ratings ranged from 1.0 to 3.0 with an average of 2.1. Scrubber control efficiencies for sulfur oxides ranged from 41.6 to 80.1 and averaged 61.5. The scrubber control efficiencies and average hood capture efficiencies yield estimates of total system abatement efficiencies for sulfur oxide emissions based on Method 1 which ranged from 9 to 39 and averaged 23 percent. Total system abatement efficiencies based on Method 2 are estimated to range from 13 to 66 and average 37 percent. Estimated total system abatement efficiencies for sulfur oxides thus ranged from 23 to 37 percent depending upon the method of computation of average hood capture efficiency.

7.3.3 Carbon Monoxide

For the six carbon monoxide tests conducted, the average greenness ratings ranged from 1 to 3 and averaged 1.6. Scrubber control efficiencies for these tests ranged from greater than 35 to greater than 84 and averaged greater than 54 percent. Total system abatement efficiencies for carbon monoxide based on Method 1 are estimated to range from 13 to 54 and to average from 18 to 38 percent. Total system abatement efficiencies based on Method 2 are estimated to range from 21 to 92 and to average from 28 to 61 percent. Total estimated system abatement efficiencies for carbon monoxide ranged, therefore, from 18 to 61 percent. Only three of the six tests conducted exhibited inlet emission rates which were not less-than values. No outlet emission rates for any of the tests were greater than the limit of detectability. Therefore, these data must be considered approximate indications of total system abatement of carbon monoxide emissions.

7.3.4 Oxides of Nitrogen

All 13 measurements for oxides of nitrogen made at the inlet and outlet of the scrubber indicated that outlet concentrations are equal to or greater than inlet concentrations. Therefore, control efficiencies were designated as identically equal to zero. As a result, total system abatement efficiencies for nitrogen oxides are zero by definition.

7.3.5 Benzene and Homologues

For the six benzene emission tests conducted, the greenness ratings ranged from 1.7 to 3 and averaged 2.3. The scrubber abatement efficiencies for benzene emissions ranged from greater than 57 to greater than 85 and averaged greater than 71 percent. Total estimated system abatement efficiency ranged from 19 to 33 percent and averaged from 21 to 28 percent using Method 1 for estimation of hood capture efficiency. Total estimated system abatement efficiency based on Method 2 ranged from 23 to 33 and averaged from 24 to 31 percent. Total estimated system abatement efficiency for benzene ranges, therefore, from 21 to 31 percent. Four of the six tests exhibited concentrations which were less than the limit of detectability. Therefore, these results must be considered approximate abatement efficiencies for benzene emissions.

The samples obtained for the six tests for benzene emissions were also analyzed for benzene and homologues. Scrubber control efficiencies for benzene and homologue emissions ranged from nil to 94 and averaged 34 percent. Total estimated system abatement efficiency based on Method 1 ranged from nil to 31 percent and averaged 11 percent. Total estimated system abatement efficiency based on Method 2 ranged from nil to 48 and averaged 16 percent. The total estimated system abatement efficiency of benzene and homologues, therefore, ranges from 11 to 16 percent based on these six tests.

7.3.6 Total Light Hydrocarbons

For the six tests conducted for total light hydrocarbons (expressed as methane), the greenness ratings ranged from one to three and averaged 1.5. Scrubber control efficiencies for total light hydrocarbons ranged from nil to 98 and averaged 23 percent. Four of the six tests indicated control efficiencies of zero. Total estimated system abatement efficiencies for total light hydrocarbon emissions based on Method 1 ranged from nil to 53 and

averaged 12 percent. Total estimated system abatement efficiencies ranged from nil to 90 and averaged 21 percent based on Method 2. The total estimated system abatement efficiency of total light hydrocarbons, therefore, ranges from 12 to 21 percent.

7.3.7 Methane and Homologues

Samples analyzed for methane and homologues were the same as those used to measure total light hydrocarbons. For these six tests, scrubber control efficiencies for methane and homologues ranged from nil to 67 and averaged 17 percent. Total estimated system abatement efficiencies based on Method 1 ranged from nil to 33 and averaged 8 percent. Total estimated system abatement efficiency based on Method 2 ranged from nil to 57 and averaged 14 percent. The total estimated system abatement efficiency for methane and homologues, therefore, ranges from 8 to 14 percent.

7.3.8 Ethylene and Homologues

The test results for ethylene and homologues were obtained from the same samples analyzed for methane and homologues. The scrubber control efficiency for ethylene and homologues ranged from nil to 99.7 and averaged 39 percent. Total estimated system abatement efficiency based on Method 1 ranged from nil to 54 and averaged 21 percent. Total estimated system abatement efficiency based on Method 2 ranged from nil to 92 and averaged 36 percent. The estimated total system control efficiency for ethylene and homologues, therefore, ranges from 21 to 36 percent.

7.3.9 Summary of All Contaminants

Table 7.3.9-1 summarizes the total estimated atmospheric emissions, including hood fugitive emissions and scrubber stack emissions, for those substances presented in Tables 7.0-1 through 7.0-14. The table shows that 82 percent of all uncontrolled and measurable emissions are particulate matter. The remaining 18 percent consists of sulfur oxides, carbon monoxide, oxides of nitrogen, benzene and homologues, total light hydrocarbons, methane and homologues, and ethylene and homologues.

The other contaminants listed in Table 3.2-2 which were sampled at the scrubber inlet and/or outlet are addressed in Table 7.3.9-2. This table lists the emission factors

measured and expressed in terms of the limits of detectability. Where process data could not be obtained to permit calculation of emission factors, the results are expressed in concentration terms (parts per million).

8.0 DISCUSSION OF RESULTS AND CONCLUSIONS

This section presents a discussion of the investigations based upon the data and results presented previously. A summary of the limitations of the study is also included.

8.1 Historical Performance Assessment

Sections 5.1.1 and 5.1.2 identify the documents and process measurements that were utilized to evaluate the system with respect to its operability and maintainability. One prime indicator is the required maintenance as documented in maintenance logbook entries.

While many system components contributed to control system downtime, only five major categories appeared consistently in the logbook. Throughout the lifetime of the control system, the failure of the induced-draft fan and/or the main louvers accounted for prolonged periods of downtime. The main fan failures, according to logbook entries, are traced to problems with fan bearings.

The failure of the induced-draft fan bearings contributed a large percentage of system downtime during which pushing emissions were emitted directly to the atmosphere. The control system, despite extensive maintenance, was not in operation due to failures of the main fan or louvers for about 70 days during the period 1972 to 1975.

In researching the logbooks, it was hoped that any failures associated with seasonal variations would be obvious. For example, one such indicator would be failure of the scrubber pumps due to freeze-up. However, no discernible and consistent failure of the recirculation system pumps was observed. Approximately 15 failures of the pump were reported between 1972 and 1975.

Failure of the door machine due to its modifications to accommodate the control system was not a major contributor to system downtime. Logbook entries indicate that the modified door machine experienced major failure 15 times throughout the system operation. These failures did not appear to be seasonal. Since the failures of the door machine cited in this report are malfunctions caused by modifications of the standard door machine and exclude downtime attributable to standard door machine performance, it appears that modification of existing door machines to house controls and subsystems does not materially affect the standard door machine's performance since only about 15 failures are documented to have occurred.

Malfunctions associated with either the door or the Rayco cylinder, which actuates the control system, appear to be the most frequent entries appearing in the maintenance logbook. More than 50 relatively major failures associated with these system components were documented to have occurred during the system lifetime. Further, these Rayco system failures are increasing with system age. The failures rest predominantly with the inability of the Rayco cylinder to open the fume main doors and thereby actuate the system to collect coke-pushing emissions. Thermal overload protectors in the cylinder effectively prevent the system from reaching full operational mode when the doors cannot be opened fully. The contributing causes include: bent doors, degradation of the hood snorkel lining which causes the fume main doors to bind, excessive suction in the fume main, and alignment problems. Most of these problems tend to increase with age. This is especially true of the relatively complex fume main system that must be accessed by the collection hood during each and every push. The harsh environment above the coke oven battery certainly contributes to gradual degradation of this portion of the emission control system.

From those malfunctions observed when the on-site Clayton observers evaluated the system visually, it appeared that the control system operator (also the coke guide operator) was frequently unaware of control system failure. In one such instance, it was observed that the Rayco cylinder tripped the circuit breaker after traversing approximately 90 percent of its stroke in attempting to open the fume main doors. The limit switch, due to the system design, did not activate and open the louvers on the main fan. Therefore, coke-pushing emissions were not captured or scrubbed.

Failures associated with controls and instruments constitute the fifth category of system downtime. About 10 failures due to these components were noted throughout the three-year system operation. These failures, therefore, are not a major contributor to system downtime; significantly, the majority of these failures occurred during the initial year of system operation.

The historical performance, in general, indicates that between 150 and 200 failures of the system, corresponding to between 10 and 20 percent of system operating time, occurred during the control system's three-year operation as documented in the maintenance logbooks. This estimate is conservative because the noted downtime did not always involve entire days of system shutdown.

Figure 6.1.1 displays trends in maintenance requirements with regard to historical economics as deduced from cost accounting records at Ford Motor Company. These data indicate that excessive maintenance expenditures or trends in system degradation (manifest by gradual increase in maintenance cost

requirements) cannot be attributed to this control system. Accurate assessments of man-hour requirements or part replacement costs could not be deduced from the limited cost data available. The costs of maintenance of the Ford/Koppers emission control system amount to approximately $0.15 per ton of coke produced, on a yearly basis.

8.2 Assessment of the Abatement Efficiency

Results presented in Section 7.0 indicate that, when operational, the control system abates pushing emissions with an efficiency ranging from nil to 65 percent, depending upon the contaminant considered. While scrubber efficiencies are relatively high for most contaminants, the ability of the hood to capture emissions under a wide variety of push conditions is seriously questioned. As discussed previously, emissions must be captured and scrubbed to be considered abated. Therefore, total abatement efficiency is decreased in almost direct proportion to hood capture efficiency. Tables 7.0-1 to 7.0-14 indicate that, in general, the system is capable of capturing up to 65 percent of the pushing emissions (depending upon greenness). The scrubbing efficiency for filterable particulate is greater than 99 percent. Since the predominant pushing emissions (on a mass basis) consist of particulate matter, we conclude that the Ford/Koppers control system reduces the most significant portion of the coke-pushing emissions to between one-half and one-fifth of their uncontrolled mass emission rate when only a moderate number of green pushes are encountered. Considering the EPA estimate of 30,000 tons of particulate and gaseous contaminants annually emitted from all coke ovens[1], between 15,000 and 24,000 tons of particulate could be prevented from entering the atmosphere annually if all coke ovens in the U.S.A. were equipped with this control system. Therefore, this emission control system is certainly a contribution to the developing abatement technology required to control this large source of atmospheric contaminants. However, certain process and system modifications are required to upgrade the overall control (capture and scrubbing) efficiency to a higher level.

These conclusions are contingent upon the accuracy of fugitive emissions estimating techniques used in this study.

8.2.1 Hood Performance

Sections 6.2 and 6.3 discussed the method of determining the hood capture efficiency. Regression analyses indicate that Method 1 provides a correlation which, statistically, is more highly significant (-0.99) than that defined by Method 2. In Method 2, the engineer-observer's visual estimate of hood capture efficiency was correlated to the average greenness rating of the

coke push. This correlation exhibited a correlation coefficient of -0.90. This indicates that the estimate of average hood capture efficiency by visual techniques is well correlated with the coke push greenness rating. However, this empirical correlation does not necessarily indicate a high accuracy of the absolute value of the estimate of hood capture efficiency. It is tempting to conclude that the second method provides a better correlation. Yet, almost certainly, the engineer-observer is somewhat prejudiced by the greenness of the push in trying to determine the hood capture efficiency visually. The extent to which the estimate is numerically erroneous is indeterminable. A useful guide is available from the Method 1 results which are more rigorous in nature but suffer from some variations in the experimental and process conditions. Without additional data or more refined techniques for estimating fugitive emissions, we conclude that these two estimating techniques should provide upper and lower bound estimates of hood capture efficiency.

It should be emphasized that the data obtained are firmly tied to process conditions existing during hood efficiency testing. If some anomalous process factors produced atypical push conditions, the results are biased accordingly.

To assist in depicting the degree to which the hood design contributes to emissions capture depending upon push greenness, Figures 8.2.1-1 through 8.2.1-3 display photographically the fugitive hood emissions for clean, moderate, and green pushes, respectively. Two views are provided for each type of push. For each view, three photographs show the approximate beginning, middle, and termination of the push. The represented photographs are chosen from a large selection and are judged typical of each type of push.

These photographs visually depict the extent of fugitive emissions which when estimated by the best available techniques indicate that hood design is likely inadequate. Table 8.2.1 documents oven numbers and push times associated with the photographs.

8.2.2 Scrubber Performance

Clayton Environmental Consultants concludes that the Kinpactor scrubber is performing well in abating particulate pushing emissions considering the relatively high control efficiency which the scrubber exhibits for filterable particulate emissions. The documented control efficiency is somewhat lower than that reported

in the Design Manual; however, the scrubber pressure drop measured during this evaluation program was somewhat less than design conditions.

According to Table 7.0-5, scrubbing efficiencies for sulfur dioxide average 42 percent. Normally, liquid scrubbing of sulfur dioxide is more efficient. In this application, however, the concentration of sulfur dioxide in the inlet gas is very low. Scrubbers used to abate sulfur dioxide emissions (in the range of 500 to 3,000 parts per million of sulfur dioxide) adequately control gas streams. However, this is contrasted to the concentrations found in this study, averaging slightly more than 10 parts per million. The second contributing factor causing a low sulfur dioxide scrubbing efficiency is likely attributed to the recirculated scrubbing liquor. As the scrubbing liquor becomes saturated with sulfur dioxide, the ability of the water to collect and retain sulfur dioxide is somewhat impaired if additive chemical neutralizers are not used in the scrubbing liquor.

The evaluation of the collectability of sulfur trioxide in the Kinpactor is limited by the data available. Clearly, the data in Table 7.0-6 are sparse and widely scattered. These data do not permit meaningful conclusions due to the extremely low concentrations of sulfur trioxide detected. Despite the two low efficiency points cited in Table 7.0-6, we expect that the Kinpactor removes sulfur trioxide emissions relatively efficiently from the incoming airstream. High removal efficiencies are found frequently in scrubbers of much lower contact power. Consequently, it may be expected that the Kinpactor reduces what little sulfur trioxide is emitted and captured during a push to an acceptable outlet level.

The ability of the Kinpactor to remove carbon monoxide emissions to the level indicated in Table 7.0-8 is surprising because no additives are introduced into the recirculated scrubbing liquor and because of the low solubility of carbon monoxide in water. Generally, even high-energy scrubbers are incapable of removing carbon monoxide. However, the data indicate that in at least one test, control efficiencies in excess of 80 percent were measured. Again, however, the low concentrations of carbon monoxide found contribute some uncertainty to the measured control efficiencies.

Table 7.0-9 shows that the scrubber efficiency for oxides of nitrogen is zero in all 13 tests. A statistical analysis of the inlet and outlet concentrations was undertaken to determine whether the inlet and outlet measured concentrations are actually

distinguishable in a statistical sense. The results indicated that, due to the variability in measurement and the scatter of the data, the mean outlet concentration was indistinguishable from the mean inlet concentration. As such, control efficiencies were concluded to be nil.

As indicated in Section 5.2.4, the technique for sampling and analyzing for oxides of nitrogen is an EPA reference method and involves grab sampling. An evacuated flask is used to sample a certain amount of the gas stream at the inlet or outlet during a 15-second interval. Timing is critical in that the inlet and outlet sampling stations must withdraw samples from the stack gas simultaneously while taking into account the time lag between the inlet and outlet locations. Attempts to refine this method produced no significant improvement in resolving differences in concentrations from inlet to outlet. It can be inferred, therefore, that low scrubber efficiencies for oxides of nitrogen are attributable either to a large variability in oxides of nitrogen concentrations during a push or that the scrubber does not measurably remove oxides of nitrogen. The solubility of nitrogen dioxide, usually the principal constituent of oxides of nitrogen emissions, is such that measurable amounts should be dissolved in the scrubber water. However, because the scrubbing liquor is recirculated, it is possible to saturate the scrubbing liquor in a short period of time. Therefore, it is likely that if the scrubber does exhibit a measurable abatement efficiency for oxides of nitrogen, this efficiency would be quite low.

Tables 7.0-10 and 7.0-11 indicate a high variation in scrubber efficiency for benzene emissions as well as benzene and homologue emissions, respectively. High molecular weight benzene homologues are, of course, more easily scrubbed because these compounds tend to exhibit lower volatility. The exact make-up of the mixture of benzene homologues cannot be determined easily. Therefore, no judgments can be made as to the average molecular weight of this group of contaminants. However, the high variability in calculated control efficiency attests to either a wide variation in the species being emitted to the scrubber or simply a scatter in the measured concentrations. In any event, data do tend to indicate that the scrubber efficiency can range from zero to 94 percent for these types of emissions. Aqueous scrubbing of organic compounds, especially using recirculated scrubbing liquor, can be expected to yeild low control efficiencies in any aqueous scrubber. The data in this case do tend to indicate that the

Kinpactor is removing measurable amounts, to an average of 34 percent of benzene and benzene homologues emissions.

Total light hydrocarbons represent a broad classification of organic compounds whose molecular weight can range from 16 a.m.u. (atomic mass units) on up. The ability of the scrubber to remove these compounds, especially using an aqueous scrubbing liquor, depends to some extent on the molecular weight as it determines approximate volatility or approximate condensation temperature. As indicated above, variations either in measured inlet or outlet concentrations due to natural data scatter or variations in pushing emissions can account for control efficiencies which range from zero to 98 percent for total light hydrocarbons as shown in Table 7.0-12. However, four of the six data points do indicate that the scrubber produces immeasurable reductions in total light hydrocarbons.

Similar scatter of data is evident in Tables 7.0-13 and 7.0-14. This scatter is attributable to a variation in pushing emissions or to inherent measurement errors. In any event, the ability of the Kinpactor to remove methane and homologues, and ethylene and homologues is not quantified firmly enough to permit conclusions as to the characteristic scrubbing efficiency of the Kinpactor in abating these substances. The data do indicate, however, that the scrubbing efficiency is likely to be low and between zero and 40 percent.

As indicated, sampling measurements were undertaken for the other species listed in Table 3.2-2. Because all values indicated existing concentrations which are less than the limit of detectability for the analytical technique required, no accurate assessment of scrubbing efficiency could be made. In general, however, it is likely that high molecular weight substances are removed to a measurable if not efficient degree in the Kinpactor scrubber. This conclusion is based upon the other non-zero scrubbing efficiencies documented in Tables 7.0-1 through 7.0-14. In general, those species which are particulate in nature are likely removed to an efficiency of 90 percent or greater. Gaseous contaminants are likely removed to an efficiency somewhere between zero and 40 percent, depending upon the molecular weight of the contaminant and the solubility in the recirculated aqueous scrubbing liquor.

8.3 Applicability to Other Installations

The question of whether the scrubber control efficiencies, hood capture efficiencies, and total system abatement efficiencies are those which can be expected to be encountered in other coke batteries is related to many factors. In general, the geometry and operation of the coke ovens at Ford Motor Company are nearly identical to other installations. One process-related parameter, the degree-of-greenness, is an important consideration in extrapolating expected system performance at other batteries. At installations where the frequency of green pushes is less than that encountered during the testing period at the Ford Motor Company installation, it is expected that hood capture efficiencies would be measurably improved over those reported in this study. Conversely, coke facilities which experience more green pushes should expect increased fugitive (uncaptured) emissions from a similar control system over those reported in this study.

The question of representativeness must be addressed as it relates to the average push greenness encountered at Ford during the test period. Using the engineer-observer's estimate of the degree-of-greenness (having concluded empirically that the Ford observer was biased; see Section 6.3), the percentage of green pushes experienced during testing is compared with the percentage of green pushes documented during all other times when the engineer-observer was on-site. Results show that, during the testing documented in Tables 7.0-1 to 7.0-14, only 47 percent of the pushes could be classified as "clean" during the test period, whereas 64 percent were "clean" pushes during non-test periods. Because hood capture efficiency, and therefore total abatement efficiency, is a sensitive function of degree-of-greenness (see Figure 6.3-4), the specific data in this evaluation may be somewhat biased toward a detrimental evaluation. The extent to which 47 percent clean pushes is characteristic of other coke-making facilities determines the degree to which expected control efficiencies can be extrapolated to those facilities.

While undoubtedly the geometry of ovens (mainly the height of the ovens) influences most directly the hood capture efficiency, collection efficiencies can be obtained which are at least as good as those documented in this study by tailoring the hood design to a particular battery being controlled.

Unless suitable design modifications are made to the collection hood-quench car design, we would expect that collection efficiencies would be identical to those displayed in Figure 6.3-4, assuming similar push greenness. The best collection efficiency estimated (subjectively), even for a clean push, is approximately 90 percent. By measurement, the collection efficiency is substantially less than this, being about 60 percent for a clean push. From the system observations,

these low efficiencies are likely attributable to both the system design and the changes made to the system throughout the life of the control system. We emphasize that these conclusions are based upon the accuracy and precision of the techniques used to estimate fugitive emissions.

In summary, we conclude that the data obtained in this study are representative of the Ford/Koppers control system performance. Therefore, these data are considered applicable to predicting total abatement efficiencies at other installations. However, estimated hood capture efficiencies set forth in this report should be interpreted with an understanding that the percentage of green pushes during the sampling phase of the study was somewhat atypical of routine process conditions at the Ford coking facility.

8.4 Limitations of the Study

The evaluation of the Ford/Koppers control system was designed to provide data and quantitative estimates useful in assessing the long-term performance of the system with regard to maintenance, operability, and the ability of the system to abate pushing emissions effectively. These objectives are fulfilled by the results presented in this report. However, a few considerations that are relative to the application of this sytem for controlling coke-pushing emissions have not been addressed in this project.

The original roster of contaminants displayed in Table 3.2-2 comprises those substances Clayton Environmental Consultants, Inc. expected to find in the coke-pushing emissions. Many of these were not present at the lower limits of analytical detectability. Therefore, if some compounds in the push emissions have gone undetected in this study, it is because of analytical sensitivity or because their potential existence was largely unknown when the study was designed and executed. In light of its overall experience with coke oven emissions, Clayton Environmental Consultants, Inc. believes that the roster of contaminants sampled in this study is unusually comprehensive and representative of the substances believed to be present in coke-pushing emissions. Clearly, however, the nature and concentration of these species could vary from installation to installation depending upon the particular type of coal used and the coking practices employed at the facility.

The possibility for a diversity of chemical reactions between the scrubbing liquor and its contents and the contaminants coming into the scrubber gives rise to legitimate questions regarding by-product or secondary emissions from the scrubber which could go largely undetected. The chemistry of reaction between recirculated scrubbing liquor and high molecular weight contaminants, while being unlikely, could produce chemical species whose physical and chemical properties

do not lend themselves to collection or analysis by the sampling and analytical procedures used in this study. Furthermore, any accumulation of collected emissions in the recirculated scrubbing liquor, and chemical reactions among these captured contaminants, could lead to emission to the atmosphere of other materials than those sampled. This study neither presumes to confirm nor negate such possibilities.

9.0 RECOMMENDATIONS

Because this comprehensive evaluation indicates that the performance of the Ford/Koppers system could be improved significantly — considering both hood capture and scrubber efficiencies — some improvements in the design and operation should be made to upgrade performance. Our recommendations include alterations to the hood design, quench car design, scrubber design, fan capacity, and other general aspects of the control system.

9.1 Hood-Quench Car Clearances

The post-start-up modifications delineated in the Koppers Design Manual have contributed to some decrement in hood capture efficiency compared with the original design. By increasing the gap between the hood sides and the built-up quench car, air infiltration and consequent contaminant escape have increased. Furthermore, by removing the synchronization unit and thereby requiring that the end of the quench car be removed for the operator, fugitive emissions have been further increased. All of these changes have contributed to a decrement in hood capture efficiency estimated to be in the order of 20 to 30 percent below the original design specifications. While no recommendations can be made as to how to eliminate the problem of mobile side plates on the hood, as they degrade in this environment, and the necessity for the operator to see the coke, it is certain that this air gap must be minimized if hood capture efficiency is to be improved.

9.2 Redesign of Hood Structure

Aside from building up the sides of the hood to reduce clearances, capture efficiency could be improved by redesign of the hood structure. Because the active portion of the hood covers less than 50 percent of the quench car at any one time (see Section 4.2), a considerable portion of the hood face presented to the quench car is made up of a solid plate designed to conduct emissions to the center of the hood. If the entire hood were made an active collector (that is, by making the entire hood cross section an open area), undoubtedly a large percentage of fugitive emissions would be collected. However, because it is necessary for the quench car to move underneath the hood to provide a level load of coke, green pushes will continue to emit contaminants from that portion of the quench car not under the hood. The only apparent solution is to provide a hood large enough to cover the entire quench car, including the length that the quench car must move leveling the coke. Such an alteration would require a large increase in exhaust ventilation volume. This is especially critical to operating costs in consideration of the large pressure drop already required in the

venturi scrubber. Nonetheless, it is likely that the only practical way to effect a measurable increase in the hood collection efficiency is by redesign of the hood and by increase in the hood ventilation exhaust volume.

9.3 Scrubber Operation

As indicated in Section 8.2.2, the scrubber is very efficient in abating particulate matter conveyed to it. The extent to which this collection efficiency can be increased is largely dependent upon the ability of the system to be made to operate with a larger pressure drop across the throat of the scrubber. Currently, liquid-to-gas ratios are sufficient and are in agreement with the design concept. As such, the only room for improvement likely rests in increasing turbulent contact in the scrubber throat. Substantial removal of other contaminants can likely not be improved upon without the use of chemical additives to the scrubbing liquor. However, the merits of doing so are questionable because of the already low concentrations of these contaminants measured in the sampling phase of this study.

9.4 Process and System Modifications

Opacity levels from the scrubber outlet stack are unnecessarily high for the green pushes. Unless green pushes can be eliminated, it would be necessary to upgrade scrubber performance in order to comply with existing opacity regulations. This can be done largely by providing more fan power, if required, closing off the venturi throat to provide intense turbulence, and, generally, doing whatever is necessary to minimize the number of green pushes on the battery.

As indicated in the discussion of maintenance problems, the movable and otherwise somewhat complex mechanisms subjected to the harsh environment adjacent to the coke side of the batteries are subject to gradual deterioration, and therefore induce chronic maintenance problems. Failure of the Rayco cylinder to fully open the doors of the fume main of each oven can likely be corrected by installation of a larger, more powerful unit. Furthermore, redesign of louvers and doors on the fume main will minimize and eliminate door binding problems and bent levers. Additionally, by making use of the originally designed butterfly damper, excessive suction in the fume main could be eliminated during the time when the Rayco cylinder is attempting to open the doors. These modifications, while relatively simple, should provide a system that requires less maintenance and consequently higher reliability in abating pushing emissions a larger percentage of the time.

As indicated, the design of the automated, main fan louvers requires that the fan change from an idle to fully-operational mode once the fume main doors are opened completely. Unfortunately, based on long-term system observation, the coke guide operator sometimes actuates the system 15 minutes prior to a push (depending upon production scheduling between "A" and "B" Batteries). Because this results in excessive and unnecessary energy consumption, the installation of an alternate control scheme for the main fan louvers is recommended. By using the pusher ram movement as a signal to the emission control system, the fan would not assume full operation until the beginning of the push. A timer circuit would be useful to provide the proper shutdown sequence after the pusher ram withdraws from the oven just pushed.

Lastly, by minimizing green pushes, the control system would function at a much higher level of emissions abatement. Not only would overall efficiency be improved measurably, but the absolute amount of emissions which are being controlled to a given efficiency level would result in a further increase in absolute abatement. Certainly, maintenance performed at Ford is as thorough as that performed at other coke batteries. However, the abnormally large number of green pushes observed during portions of the June and July testing indicated that some malfunctions in process conditions are possibly responsible. This would indicate that as much or more attention must be given to minimizing emissions by manipulation of the process conditions as is given to installation and operation of pushing emission control systems. Such process modifications might include extension of coking time or increased energy input to the ovens to raise coking temperature. Only then can the best possible performance be attained from application of such a coke-pushing emission control system.

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7. Semrau, K.T., "Correlation of Dust Scrubber Efficiency," Journal of the Air Pollution Control Association, Volume 10, No. 3, June, 1960.

8. Bowker, A., and G.J. Lieberman, Engineering Statistics, Prentice-Hall, Inc., 1959.

FOREWORD TO FIGURES AND TABLES

The following figures and tables are numbered according to the report section in which they are first presented. In some cases, "families" of figures and tables bear the same section number; multiple figures and tables within a section are appropriately suffixed by a hyphen followed by a sequential number. Some families of tables and/or figures, however, are interrupted by figures and/or tables having the same section number depending upon the order of presentation in the report text within a given section.

TABLE 1.2

CHARGE RATE AND EMISSION FACTOR CONVERSION EQUATIONS*

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Charge Rates:

$$\frac{\text{Ton Dry Coal Charged}}{\text{Hour}} = 0.938 \times \frac{\text{Ton Wet Coal Charged}}{\text{Hour}}$$

$$\frac{\text{Ton Coke Produced}}{\text{Hour}} = 0.745 \times \frac{\text{Ton Wet Coal Charged}}{\text{Hour}}$$

Emission Factors:

$$\frac{\text{Pound Particulate}}{\text{Ton Dry Coal Charged}} = 1.066 \times \frac{\text{Pound Particulate}}{\text{Ton Wet Coal Charged}}$$

$$\frac{\text{Pound Particulate}}{\text{Ton Coke Produced}} = 1.342 \times \frac{\text{Pound Particulate}}{\text{Ton Wet Coal Charged}}$$

*Based on Ford laboratory report of coal moisture content and typical coke yield for June and July, 1975.

TABLE 3.2-1

EMISSION FACTORS FOR UNCONTROLLED METALLURGICAL COKE MANUFACTURE

(From EPA Compilation of Emission Factors, April, 1973)

EMISSION FACTORS FOR METALLURGICAL COKE MANUFACTURE WITHOUT CONTROLS[a]
EMISSION FACTOR RATING: C

Type of operation	Particulates		Sulfur dioxide		Carbon monoxide		Hydrocarbons[b]		Nitrogen oxides (NO_2)		Ammonia	
	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT
By-product coking[c]												
Unloading	0.4	0.2	–	–	–	–	–	–	–	–	–	–
Charging	1.5	0.75	0.02	0.01	0.6	0.3	2.5	1.25	0.03	0.015	0.02	0.01
Coking cycle	0.1	0.05	–	–	0.6	0.3	1.5	0.75	0.01	0.005	0.06	0.03
Discharging	0.6	0.3	–	–	0.07	0.035	0.2	0.1	–	–	0.1	0.05
Quenching	0.9	0.45	–	–	–	–	–	–	–	–	–	–
Underfiring[d]	–	–	4	2	–	–	–	–	–	–	–	–
Beehive ovens[e]	200	100	–	–	1	0.5	8	4	–	–	2	1

[a]Emission factors expressed as units per unit weight of coal charged.
[b]Expressed as methane.
[c]References 2 and 3.
[d]Reference 5. The sulfur dioxide factor is based on the following representative conditions: (1) sulfur content of coal charged to oven is 0.8 percent by weight; (2) about 33 percent by weight of total sulfur in the coal charged to oven is transferred to the coke-oven gas; (3) about 40 percent of coke-oven gas is burned during the underfiring operation and the remainder is used in other parts of the steel operation where the rest of the sulfur dioxide is discharged—about 6 lb/ton (3 kg/MT) of coal charged; and (4) gas used in underfiring has not been desulfurized.
[e]References 1 and 4.

TABLE 3.2-2

SUMMARY OF CONTAMINANTS
EXPECTED IN PUSHING EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Contaminant	Detectable At Inlet*	Included In Further Testing
Acetylene	No	No
Acridine	No	No
Acrolein	No	No
Ammonia	No	No
Anthracene	No	No
Benzene & homologues (as C_6H_6)	Yes	Yes
Benzo(a+e)pyrene	—	Yes
Carbazole	No	No
Carbon disulfide	No	Yes
Carbon monoxide	Yes	Yes
Chlorine	No	No
Chrysene	No	No
Cyanide	Yes	No
Ethylene & homologues (as C_2H_4)	No	Yes
Fluoranthene	No	No
Fluorene	No	No
9-Fluorenone	No	No
Hydrogen sulfide	—	No
Methane & homologues (as CH_4)	Yes	Yes
Naphthalene	No	No
Nitrogen oxides (as NO_2)	Yes	Yes
Particle sizing	—	Yes
Particulate	—	Yes
Phenanthrene	No	No
Pyrene	No	No
Pyridine	No	No
Sulfur dioxide (as SO_2)	Yes	Yes
Sulfur trioxide (as SO_3)	No	Yes
Total light hydrocarbons (as CH_4)	Yes	Yes
Total phenolics (as C_6H_5OH)	Yes	No
Total reduced sulfur (as $S^{=2}$)	—	Yes
Total sulfur oxides (as SO_4)	—	Yes

* According to "range finding" tests conducted during January, February, March, or April, 1975 wherein at least one sample showing a concentration above the limit of detectability classifies the material as detectable.

Clayton Environmental Consultants, Inc.

FIGURE 5.1.1-1

SPECIMEN OF RECORD FOR OPERATING CHECKS BY BATTERY FOREMAN
ONCE EACH SHIFT FOR CONTROL SYSTEM

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

OPERATING CHECKS ON SMOKELESS PUSHING SYSTEM ONCE EACH 8 HR. SHIFT BY BATTERY FOREMAN

DATE	1-8	1/9	1/10	1/10	1-13	1-14	1/15	1/16	1-16
SHIFT	#3	#1	#1	#2	#3	#3	#1	#1	#3
FAN BEARING TEMP. INBOARD	135	135	125	125	115	A	125	125	135
"A" STACK ROOM OUTBOARD	125	125	125	125	115	Do	125	125	130
MOTOR BEARING TEMP. INBOARD	140	130	130	150	130	Do	120	110	135
"A" STACK ROOM OUTBOARD	120	135	130	125	105	Mech	120	110	115
FAN AMPERAGE "A"&"B" AVE. BEFORE PUSH	120	110	110	110	110	Off	—	110-110	Short
HEATER ROOM AVE. DURING PUSH	240	240	240	240	240	Do	—	240-240	Short
GAS TEMP. #1 BLACK FLUME MAIN					30		—	—	
RECORDER #2 RED KINPACTOR INLET		17	INK		30	Do	—	—	
"A"&"B" #3 GREEN FAN INLET			ALL UNC		30		—	—	
HEATER ROOM #4 BLUE STACK			COLOR		75		—	—	
KINPACTOR BETWEEN PUSHES		"			No		—	—	
DIFFERENTIAL DURING PUSH			1						
WATER FLOW FLOW CHART (A&B HEAT. ROOM)		850	850		720			—	
TO PRESS. AT PUMP (A STACK)	54		54	54	56		75	80	
KINPACTOR PUMP OPERATING(M. OR S.)	N	N	N	N	N		S	S	
DRAIN VALVE ONE TURN (A STACK)									
OBSERVE ONE PUSH FROM STACK FLUME AND RECORD CONDITION BY NOON (RINGLEMANN SMOKE CHART)					0				
NOTES						1	"A" DOOR HAND WHEEL OUT OF ACTION	Pressure gage needs to be repaired	

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FIGURE 5.1.1-2

SPECIMEN OF RECORD FOR A-DOOR MACHINE DOWNTIME

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

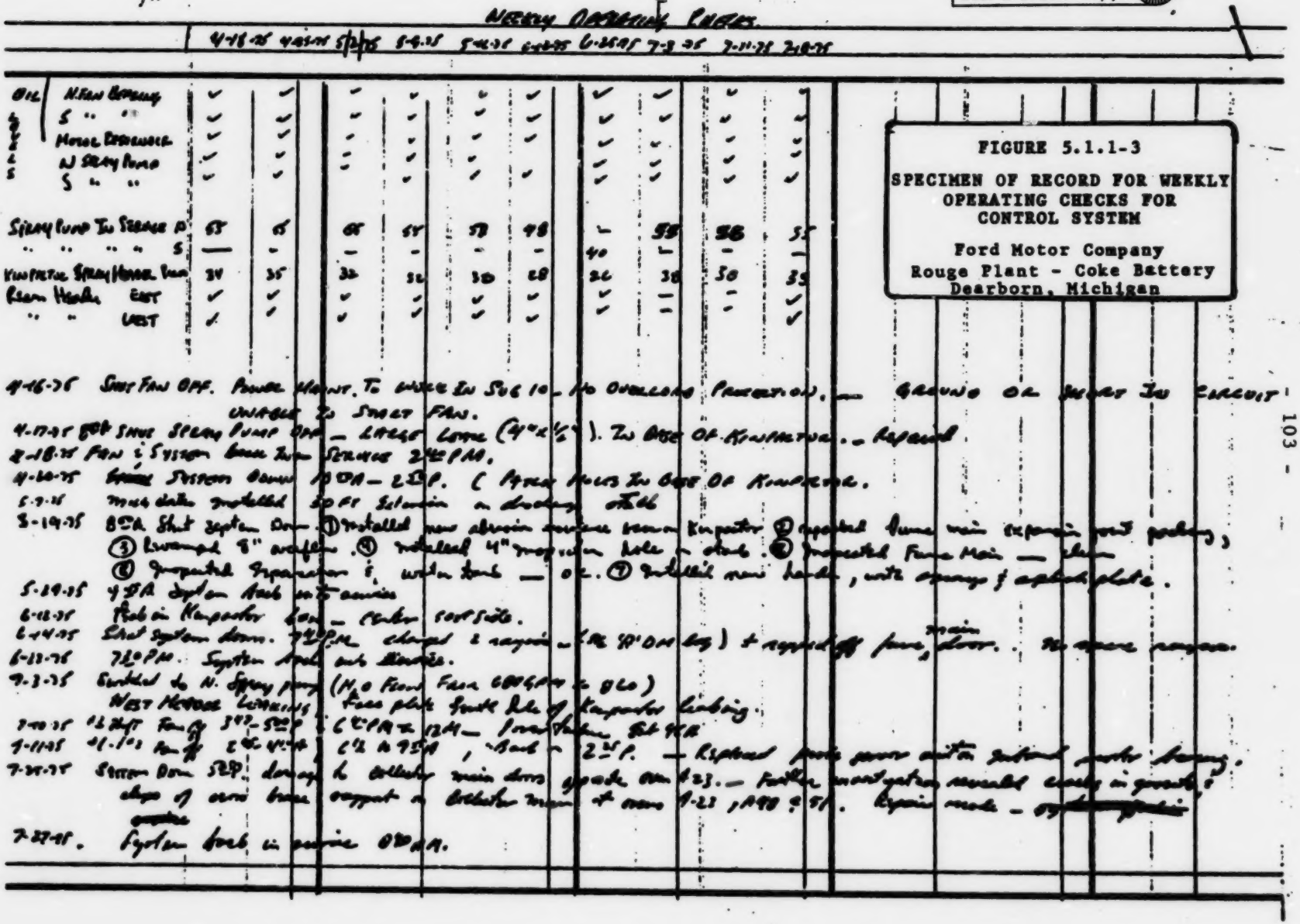
11-2-72 #2, 2:50P-3:15P., 1'0"
Blowing Fuses - Ronco Pollution Unit
11-3-72 #2, 12:00M - [redacted] - Back In. 11-4-72 6:30A. - 18'30
Unloading Reducer Pollution Hood Drive.
#4
11-9-72 #2, 12:45P-4:00P. 3'15"
Hood Tender.
#3 - 8:15P - 8:30P. 0'15"
Hood Tender.
11-10-72 #1 2:00A - 8:00A. 6'0"
Ronco Cylinder. For Hood
11-13-72 #3 10:45 - 11:45P. 1'0" - Top Shoot Rounded.
11-25-72 #1. Broken Bar Bender
" #2 - 8:00A - 4:00P. 8'0"
" #3. 10:00P - 12:00M 2'0" Motor For Compactor Burned Out.
11-26-72 #2 7:00A - 2:00P. 6'0" Blower Motor
11-30-72 #2 11:30A - 12:45P 0'50" Coke Guide Motor.
" #3 5:00P - 6:00P 1'30" Control Rod Linkage

Total Nov. 1972 29'50"

12-2-72 #1. 12M - 8:00 8'0" Control Rod Linkage.
12-3-72 #1 1:00A - 4:00A 3'0" Coupling -
12-7-72 #2 9:45A - 12:30P 3'45" Frame On Coke Guide
12-8-72 #2 3:00P - 12:00M 8'10" Key In Pinion Gear Broke.
12-9-72, #2 12M - 12:30P. 12'30" " " " "
12-20-72, #2 9:15A - 10:00A 0'45" Ground In Door Sealing
12-23-72 #3 6:00P - 8:15P 1'35" Worm Gear Defective On Coke Guide
12-28-72 #3 4:00P - 8:00P 9'0" Blowing Fuses On Tender Distributor
12-28-72 #3 11:00P - 1:00A 2'0" " " " "
12-29-72 #3 7:30P - 8:00 0'45" Tender Controls Dirty

Total Dec 1972 44'40"

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WEEKLY OPERATING CHECKS

	4-18-35	4-25-35	5-2-35	5-9-35	5-16-35	5-23-35	6-25-35	7-2-35	7-11-35	7-18-35
Oil N. Fan Bearing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
" S. " "	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Motor Bearings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N Spray Pump	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S " "	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spray Pump Tw Strainer N	65	65	65	55	58	48	—	55	56	55
" " " " S	—	—	—	—	—	—	40	—	—	—
Vinyl Metal Spray Header Pressure	34	35	32	32	30	28	32	38	30	35
Steam Header East	✓	✓	✓	✓	✓	✓	✓	—	—	✓
" " West	✓	✓	✓	✓	✓	✓	✓	—	—	✓

4-16-35 Shut Fan Off. Power Heater. To check Tw Sec 10 — No Overload Protection). — Ground on Heater Tw Circuit Unable To Start Fan.

4-17-35 Put Shut Spray Pump Off — Large Leak (4" x 1½"). Tw Base Of Riser Pipe. — Repaired

4-18-35 Fan & System Back Tw Service 2½ PM.

4-20-35 System Down 10 AM — 2½ P. (Spray Heads Tw Base Of Riser.

5-9-35 Mud dabs installed top of Silencer in Cooling Tower

5-14-35 Shut System Down. ① Installed new abrasive resistant bronze Impeller ② Repaired flume main expansion joint packing, ③ Lowered 8" overflow. ④ Installed 4" inspection hole in stack. ⑤ Inspected Fume Main — clean ⑥ Inspected Separator & water tank — O.K. ⑦ Installed new handle, with spacers & applied plate.

5-29-35 4 SPA System back to service

6-12-35 Leak in Impeller Eye — Center Cast Side.

6-14-35 Shut System down. 7½ PM changed 2 vanes (½" x 9" O.H. leg) & repaired 4 fume main door. No spare vanes.

6-22-35 7½ PM. System back to service.

7-3-35 Switched to N. Spray Pump (No Flow From Gauge = Glass) West Header Leaking. Face plate Gasket Side of Impeller Casing.

7-10-35 12 Shift Fan Off 3:07 - 5:20 P. C-12 A = 124 — Inspection Shut Off

7-11-35 21-103 Fan Off 2:45 - 4:45 P. C-12 A = 95A, Back — 2½ P. — Replaced Pump Motor with Reconditioned motor bearings.

7-21-35 System Down 5:30 P. due to Collapse main down grade Sec 23. — Further investigation revealed cracks in ground, shape of cover base support & Collector Main at Sec 9-23, 1490 & 51. Repair made — Operation

7-22-35. System back in service 8:00 A.M.

FIGURE 5.1.1-3

SPECIMEN OF RECORD FOR WEEKLY OPERATING CHECKS FOR CONTROL SYSTEM

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

FIGURE 5.1.1-4

SPECIMEN OF DATA EXTRACTED FROM MAINTENANCE DEPARTMENT LOGBOOK

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

7-22-74 Put A-battery pollution fan motor back in service at 6:10 PM. A-door machine out of service from 8:00 AM to 10:10 AM to change fume hood travel drive wheel.

8-29-74 Flume damper handle at oven 32, A-battery needs straightening.

8-31-74 A-battery fume main door arms (on oven) numbers 39, 41, 43, 48, and 49 need to be straightened.

9-1-74 We straightened the fume main door arm at 39.

9-30-74 A-battery pollution fan is down for repair for two days.

10-18-74 Angle clips were installed...on A-battery fume main. South beam was slightly twisted at top so we had to drive wedges...gave machine to operations at 4:45 PM. A-battery emissions control fan in service at 5:00 PM. All covers were installed on Kinpactor.

11-5-74 A-door machine fume hood is not operating all the time. We found that the hood carriage doesn't move far enough to trip LSDO located on the south side of the Rayco platform. The door is opened and the hood opening is

FIGURE 5.1.1-5

SPECIMEN OF DATA EXTRACTED FROM OPERATIONS DEPARTMENT LOGBOOK

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

6-26-75	Greased the rollers on the Rayco unit. A-door machine out of service 9:40 to 10:15 maintenance making adjustments to overload limit for Rayco flume hood.
6-27-75	A-door machine out of service from 8:00 to 8:30 maintenance working on flume collector, Rayco, and hood. A-door machine out of service 12:40 to 1:45 working on Rayco again.
7-1-75	A-door machine out of service 11:30 to 2:00 working on Rayco cylinder.
7-3-75	Fume collector down at 4:37 PM due to sub: ation 46A going out. Back on at 9:00 PM.
7-7-75	A-door machine out of service 11:45 to 1:00, maintenance replaced flume hood extension.
7-8-75	A-door machine out from beginning of shift through 9:15; maintenance worked on flume collector hood slide.
7-11-75	Fan motor tripped out 2:45 AM; back on for first oven after lunch at 4:10 AM but it's not working very well. The extension is going against the main also it is tripping the Rayco reset...fan motor tripped out again at 6:15.

DAILY LOG OF FUME HOOD PERFORMANCE
Ford Motor Company * Rouge Plant * Dearborn, Michigan

Date: _____ **Atmospheric Pressure** _____ **Initial:** _____

Push	Oven No.	Schedule Time	Push Time	Cross-Draft Velocity (fpm)	Fume Hood Capture (%)	Stack Opacity (%)	Coke Side Condition	Net Coal Charged (lbs)
1		0800						
2		0815						
3		0830						
4		0850						
5		0905						
6		0920						
7		0935						
8		0950						
9		1005						
10		1020						
11		1035						
12		1055						
13		1110						
14		1125						
15		1145						
Avg.								

FIGURE 5.1.3-1

SPECIMEN OF RECORD FOR HOOD PERFORMANCE

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

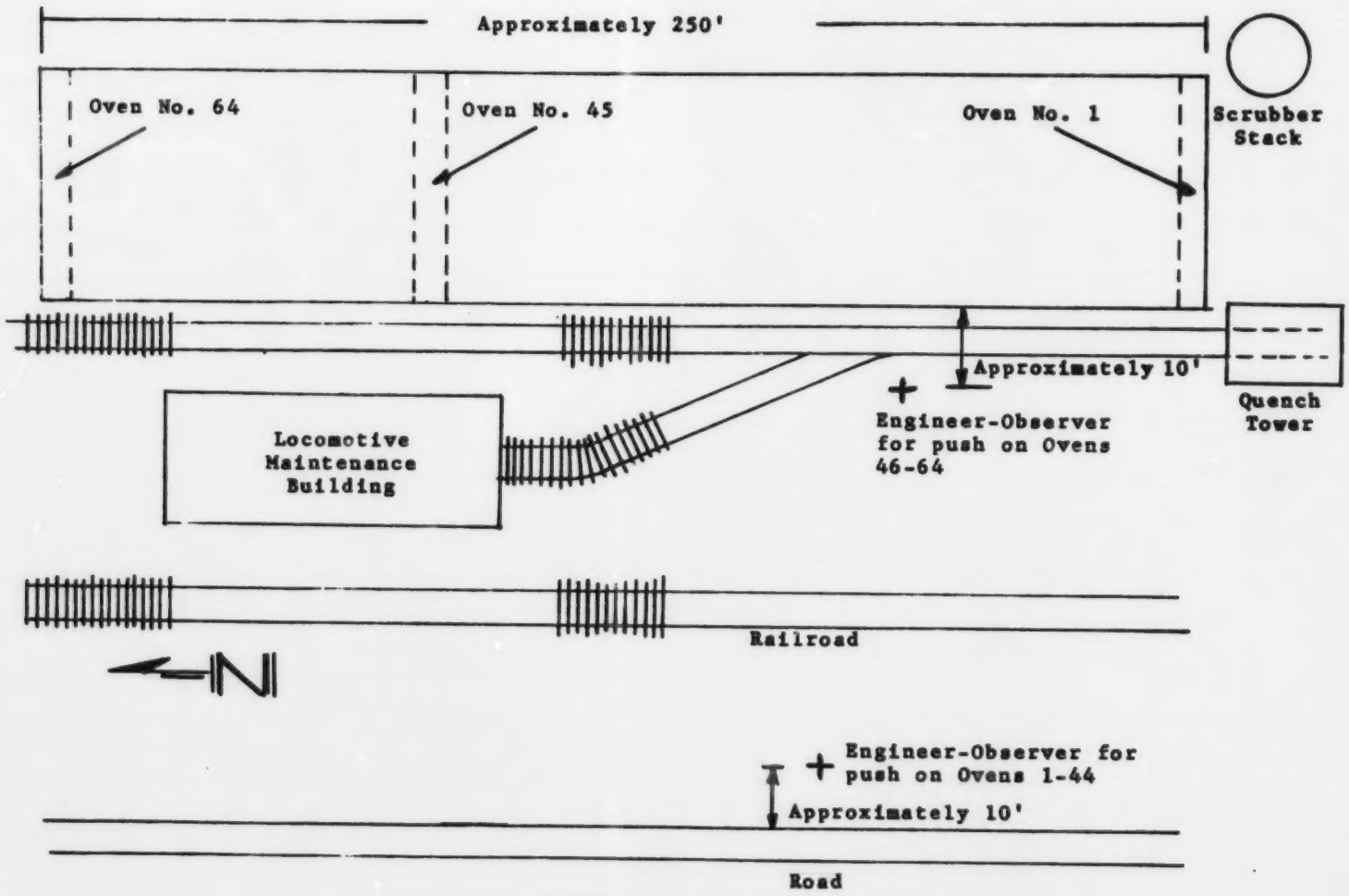


FIGURE 5.1.3-2

SCHEMATIC DIAGRAM OF ENGINEER-OBSERVER DURING A PUSH

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Clayton Environmental Consultants, Inc.

DAILY LOG OF SCRUBBER SYSTEM PERFORMANCE
Ford Motor Company * Rouge Plant * Dearborn, Michigan

Date: _____ Atmospheric Pressure: _____ Initial: _____

Push	Oven No.	Push Time	Inlet Conditions				Throat Conditions			Outlet Conditions			Recirculated Water Flow (gpm)	Fan Motor Current (amp)
			Dry Bulb (°F)	Wet Bulb (°F)	Static Pressure ("H_2O)	Velocity Pressure ("H_2O)	Pressure Drop ("H_2O)	Water Pressure (psi)	Water Temp. (°F)	Dry Bulb (°F)	Wet Bulb (°F)	Static Pressure ("H_2O)		

FIGURE 5.1.4

SPECIMEN OF RECORD FOR SCRUBBER OPERATING PARAMETERS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

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SD 8364 BATTERY "A-AX"

SHIFT 4-12 COKE OVEN HEATER INSPECTION REPORT DATE 7-20-75

	OVEN	SCH'D TIME	PUSH TIME	DELAY	AMPS	COKE CONDITION: CS	CENTER	PS	TOP	REMARKS
1	24	4:00	4:12	-12	210	A	F/S	A	F/S	
2	34	:16	4:19	-3	215	G	G	S	S	
3	44	:32	4:33	-1	220	G	G	G	G	
4	X54	:48	4:46	+2	X210	G	G	G	G	
5	X64	5:04	5:00	+4	X215	G	G	S	S	
6	6	:20	5:13	+7	215	G	G	F/S	F/S	
7	16	:36	5:25	+11	210	—		—	—	
8	26	:52	5:35	+17	215	—	—	—	—	
9	36	6:08	5:45	+23	220	—	—	—	—	
10	46	:24	6:00	+24	215	A	A	A	A	
11	X56	:40	6:22	+18	X210	—	—	—	—	
12	8	:56	6:38	+18	220	—	—	—	—	
13	18	7:12	6:53	+19	220	G	S	S/F	S/F	
14	28	:28	6:58	+30	220	S	S/F	S/F	D	
15	38	:44	7:14	+25	205	A	A	A	D	
16	48	8:00	8:12	-12	210	—	—	—	—	
17	X58	:16	8:24	-8	X200	A	A	A	A	
18	—	:32	—							
19	1	:48	8:35	+13	210	G	G	F/S	F/S	
20	11	9:04	9:11	+18	205	A	A	A	A	
21	21	:20	8:58	+22	205	F/S	F/S	A	A	
22	31	:36	9:14	+22	200	A	A	A	A	
23	41	:52	9:24	+28	200	F/S	F/S	F/S	F/S	
24	X51	10:08	9:41	+27	X200	G	F/S	G	F/S	
25	X61	:24	10:00	+24	X195	—	—	—	—	
26	3	:40	10:02	+31	200	S	S	S/F	D	
27	13	:56	10:19	+37	200	—	—	—	—	
28	23	11:12	10:54	+18	200	G	G	G	G	
29	33	:48	11:00	+48	200	G	G	S/F	D	
30	43	:44	11:03	+39	200	S	S	S/F	D	

A23 16"
AX6

FIGURE 5.1.5-1

SPECIMEN OF RECORD FOR PUSH TIMES AND CONDITION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

SD 8427 IRON MAKING OPER REV FEB 66 COAL CHARGE LOG

UNIT 12-8 BATTERY "A" DATE 2-8-25

	OVEN	TEMP.	GROSS	TARE	NET
1	4		35900	200	35700
2	14		36050	250	35800
3	24		35650	100	35550
4	34		36100	850	35250
5	44		35800	550	35250
6	6		35500	150	35350
7	16		35700	250	35450
8	26		35250	400	34850
9	36		35250	500	34750
10	46		35200	250	34950
11	8		35250	450	34800
12	18		35100	700	34400
13	28		36000	400	35600
14	38		35500	450	35050
15	48		35800	400	35400
16	1		35600	550	35050
17	11		35950	200	35750
18	21		35050	1350	33700
19	31		36800	450	36350
20	41		36150	1800	34350
21	3		40100		
22	XXX				
23	62		35550	700	34850
24	54		35950	400	35550
25	64		35850	200	35650
26	56		35650	250	35400
27	58		[illegible]	[illegible]	34800
28	51		[illegible]	[illegible]	34900
29	61		[illegible]	[illegible]	34700
30					

FIGURE 5.1.5-2

SPECIMEN OF RECORD FOR COAL CHARGE DATA

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Operator Rogers Foreman Lawlor

Reproduced from best available copy.

FIGURE 5.1.5-3

SPECIMEN OF RECORD FOR COKE OVEN FLUE TEMPERATURES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

COKE OVEN FLUE TEMPERATURES

BLOCK A DATE 2/20/75

SHIFT 8-4 READER 2704

REVERSE 1-4-5				REVERSE 2-3		
P.S.	NO.	C.S.		P.S.	NO.	C.S.
2 40 0	1	2 45 0		2 27 0	2	2 34 0
2 26 0	4	2 34 0		2 27 0	3	2 33
2 25 0	5	2 31 0		2 27 0	6	2 33
2 30 0	8	2 27 0		2 25 0	7	2 40
2 33 0	9	2 28 0		2 33 0	11	2 37
2 27 0	13	2 32 0		2 33 0	12	2 34
2 46 0	16	2 45 0		2 43 0	15	2 45
2 36 0	17	2 44 0		2 43 0	18	2 43 0
2 25 0	18	2 24 0		2 37 0	19	2 38
2 30 0	22	2 42 0		2 36 0	21	2 32
2 27 0	23	2 28 0		2 24 0	24	2 43
2 36 0	26	2 47 0		2 30 0	25	2 46 0
2 14 0	27	2 32 0		2 20 0	28	2 31 0
2 34 0	31	2 41 0		2 37 0	29	2 44 0
2 32 0	32	2 51 0		2 36 0	33	2 43 0
2 34 0	35	2 48 0		2 42 0	34	2 52 0
2 19 0	36	2 27 0		2 ~~0~~ 0	37	2 ~~0~~
2 15 0	39	2 48 0	51	2 38 0	38	2 38 0
2 00 0	41 43	2 14 0	52	2 38 0	42	2 37
2 05 0	44	2 45 0	53	2 37 0	45	2 34
2 28 0	47	2 16 0	54	2 22 0	46	2 36 0
2 31 0	48	2 32 0	55	2 27 0	49	2 39
2 41 0	52	2 34 0	56	2 46 0	51	2 46 0
	53		57		54	
49740	56	52170	58	50930	55	52680
2270	57	2371	59	2324	58	2375
	60 61		61		60	
	63 62	COAL: 2340	62		61	
	65	P.IN: 2297	63		64	
	66	C.IN: 2383	64		67	
	69	WT: 86	65		68	

Wt: 2520 SP: 4

SD 8348 IRON MAKING OPER REV AUG 73

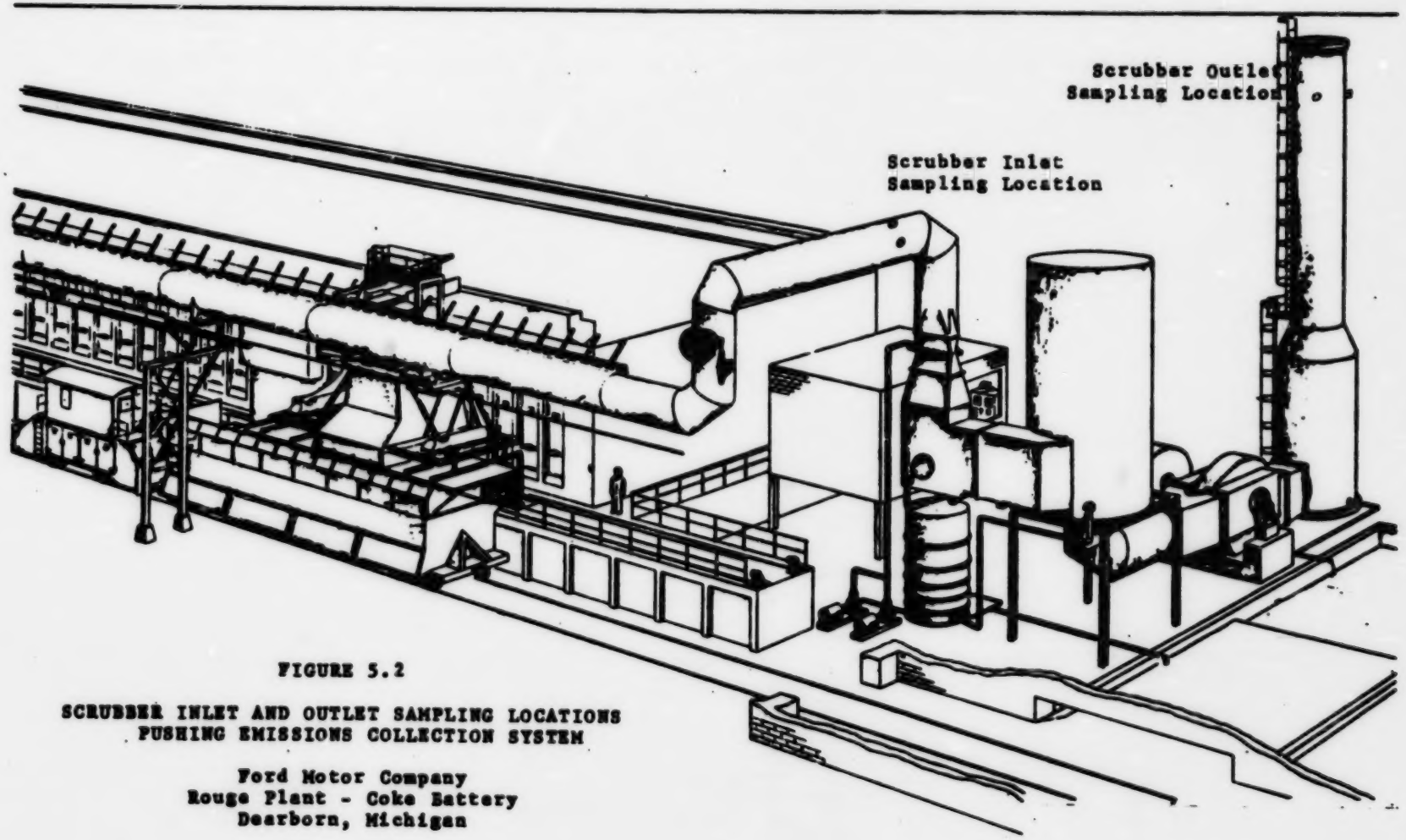


FIGURE 5.2

SCRUBBER INLET AND OUTLET SAMPLING LOCATIONS
PUSHING EMISSIONS COLLECTION SYSTEM

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

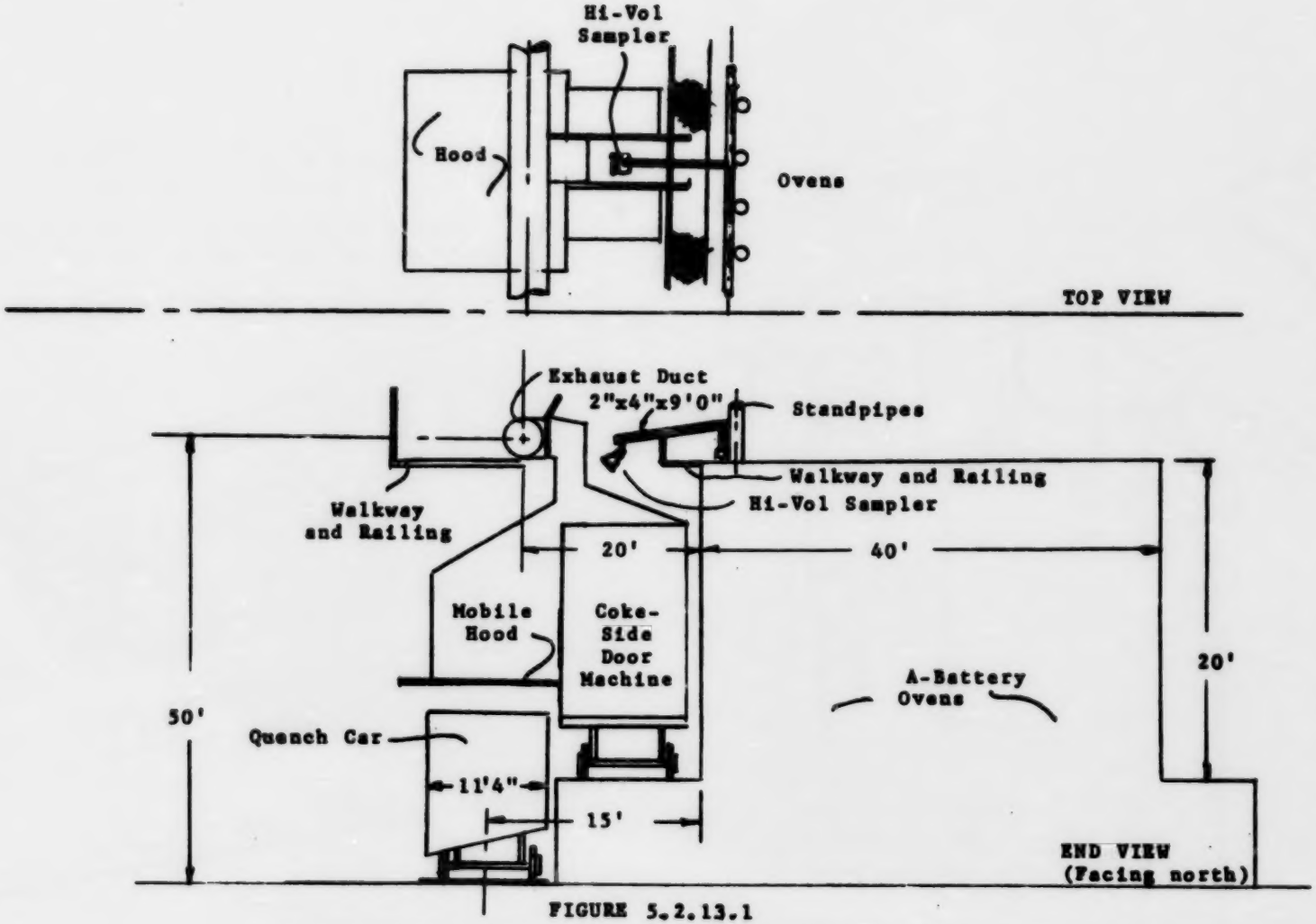


FIGURE 5.2.13.1

SCHEMATIC DIAGRAM OF HIGH-VOLUME AIR SAMPLING LOCATION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

TABLE 6.1.1-1
SUMMARY OF AVERAGE MONTHLY UTILITIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Month	Main Fan Current (amps)		Kinpactor Pump		Horsepower Used			
					Fan		Pump	Total Weighted Average*
	Before Push	During Push	Flow (gpm)	Pressure (psig)	Before Push	During Push		
8/73	129	242	747	45	1245	2340	23	1630
9/73	125	235	750	46	1210	2270	23	1590
10/73	122	235	680	47	1180	2270	22	1570
11/73	114	235	652	48	1100	2270	21	1510
12/73	116	240	614	44	1120	2320	18	1540
1/74	133	233	—	41	1285	2250	—	—
2/74	131	230	—	45	1265	2220	—	—
3/74	118	221	—	52	1140	2130	—	—
4/74	116	223	948	54	1120	2150	35	1500
5/74	119	233	855	44	1150	2250	26	1540
6/74	133	232	827	38	1285	2240	21	1620
7/74	125	239	852	51	1210	2310	30	1610
8/74	121	238	867	43	1170	2300	25	1570
9/74	120	240	866	50	1160	2320	29	1580
10/74	119	239	799	51	1150	2310	28	1560
11/74	119	240	—	49	1150	2320	—	—
12/74	116	243	—	49	1120	2350	—	—
1/75	110	242	880	47	1065	2340	28	1520
2/75	170	180	982	52	1640	1740	35	1710
3/75	124	241	—	53	1200	2330	—	—
4/75	121	235	954	54	1170	2270	35	1570
5/75	145	268	948	57	1400	2590	37	1830
6/75	186	332	776	43	1795	3210**	23	2290
7/75	116	214	839	50	1120	2070	29	1470
8/75	116	216	688	40	1120	2090	19	1460
Overall Average	127	237	778	48	1225	2290	27	1610
6,7,8/75 Average	139	254	768	44	1345	2460	24	1740

* Assuming 40 minutes of idle fan and 20 minutes of wide open fan in each push-hour.

** Suspected erroneous amperage reading

TABLE 6.1.1-2
SUMMARY OF AVERAGE MONTHLY SCRUBBER PARAMETERS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Month	Kinpactor Differential (psi)	Nozzle Pressure* (psig)	Water Flow (gpm)	Contact Power		
				Gas $\left(\frac{\text{HP}}{1000\ \text{SCFM}}\right)$	Water $\left(\frac{\text{HP}}{1000\ \text{SCFM}}\right)$	Total $\left(\frac{\text{HP}}{1000\ \text{SCFM}}\right)$
8/73	44	27	747	6.9	0.15	7.1
9/73	42	28	750	6.6	0.14	6.7
10/73	40	29	680	6.3	0.14	6.4
11/73	36	30	652	5.7	0.14	5.8
12/73	42	26	614	6.6	0.12	6.7
1/74	31	23	—	4.9	—	—
2/74	34	27	—	5.3	—	—
3/74	39	34	—	6.1	—	—
4/74	43	36	948	6.8	0.25	7.1
5/74	44	26	855	6.9	0.16	7.1
6/74	38	20	827	6.0	0.12	6.1
7/74	(20)	33	852	—	—	—
8/74	43	25	867	6.8	0.16	7.0
9/74	41	32	866	6.4	0.20	6.6
10/74	42	33	799	6.6	0.19	6.8
11/74	43	31	—	6.8	—	—
12/74	42	31	—	6.6	—	—
1/75	46	29	880	7.2	0.19	7.4
2/75	28	34	982	4.4	0.24	4.6
3/75	43	35	—	6.8	—	—
4/75	43	36	954	6.8	0.25	7.1
5/75	42	39	948	6.6	0.27	6.9
6/75	46	25	776	7.2	0.14	7.3
7/75	39	32	839	6.1	0.19	6.3
8/75	39	22	688	6.1	0.11	6.2
Overall Average	40	30	778	6.4	0.18	6.6
6,7,8/75 Average	41	26	768	6.5	0.15	6.6

* Assuming 18 psi loss from pump gauge reading due to friction and head losses.

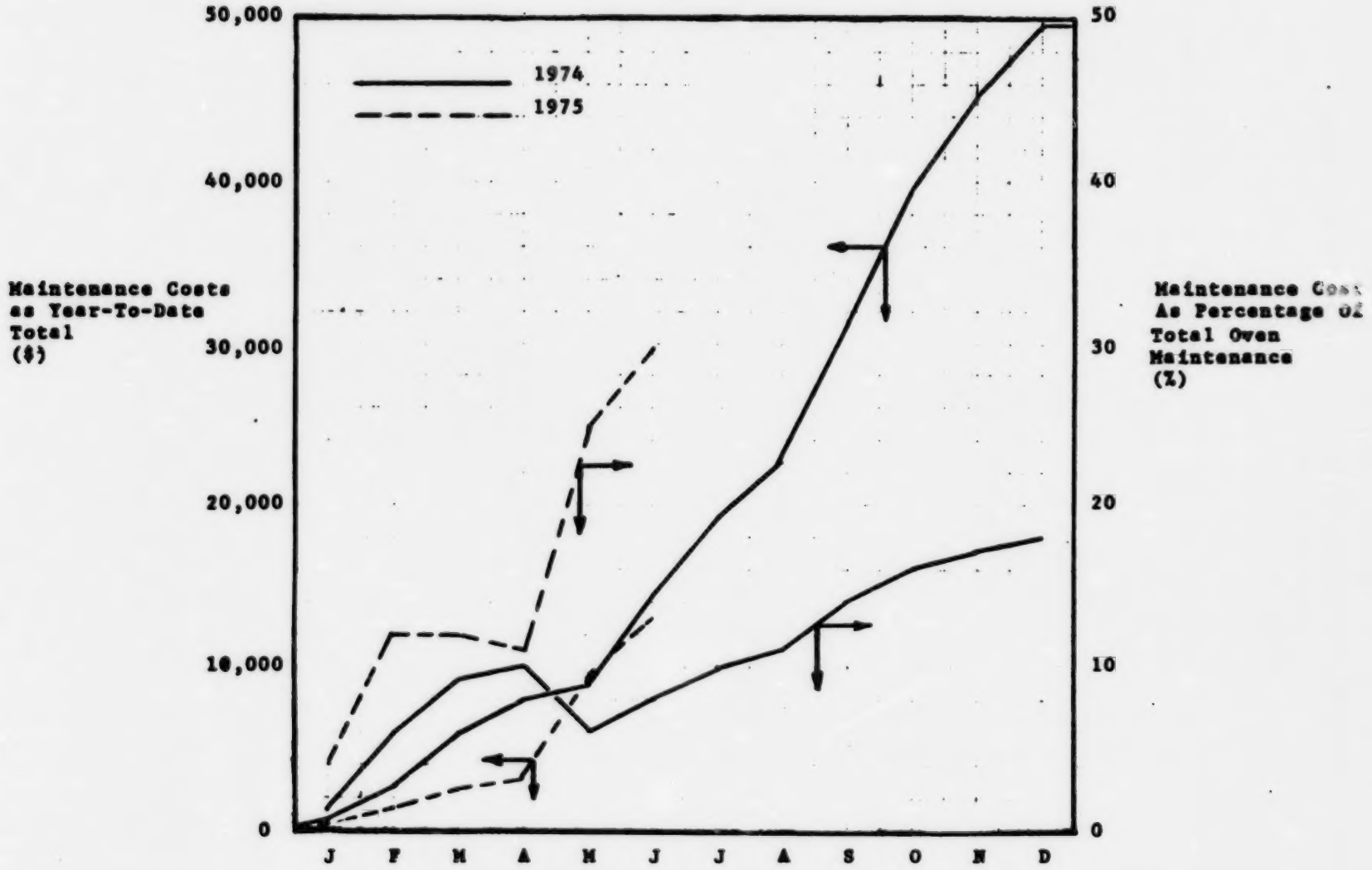


FIGURE 6.1.1
MAINTENANCE COSTS OF THE KOPPERS SYSTEM
Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

TABLE 6.1.1-3

SUMMARY OF REQUIRED MAINTENANCE DOCUMENTED IN MAINTENANCE LOGBOOK

Ford Motor Company
Rouge Plant - Coke Batter
Dearborn, Michigan

Main Fan & Fan Louvres		Pump	Door Machine	Rayco or Hood	Controls & Instruments
1972: 7-1	1974: 5-18	1972: 7-30	1972: 7-1	1972: 7-8*	1972: 12-5
7-22	5-22	11-30	10-23	7-16	12-12
7-24	5-31	12-1	12-2*	7-18	12-28*
9-4	6-2*	1973: 3-11	1973: 4-29	10-25	12-29*
11-26	6-3*	3-19	5-3	11-17	1973: 6-26
11-29	6-4*	12-14	5-26	11-19	12-22
12-21*	6-5*	12-23	6-4	12-17*	1974: 1-8
1973: 2-11	6-6*	1974: 3-22	8-2	1973: 4-3	12-12
2-17*	6-7*	7-14*	1974: 3-27	4-7	
2-18*	6-8*	7-15*	3-31	4-8	
2-19*	6-9*	7-17*	8-29	4-24	
4-19	6-14	11-28*	8-31	4-25*	
4-20*	6-17*	1975: 1-14	9-1	5-9	
4-21*	6-19*	2-16	10-18	6-1*	
4-22*	6-20	5-21		11-1*	
4-23*	6-22*			11-3	
5-29	6-24*			11-4	
6-4*	7-1*			1974: 1-25	
6-5	7-2*			3-22	
6-6*	7-7			7-21*	
6-8*	7-10			11-5	
6-19	7-11*			11-7	
6-30	7-12*			1975: 1-9	
7-8	7-13*			1-14	
7-14	7-22			1-16	
8-27	9-30*			2-5	
8-31	10-1*			3-7	
11-26	12-1			3-20	
12-22	1975: 1-27			5-2	
1974: 1-16	3-7*			5-8	
1-17	6-20			5-9	
3-22	7-11			5-10	
5-14*				5-13	
				5-30	
				6-13	
				6-14	
				6-15	
				6-21	
				6-22	
				6-23	
				6-24	
				6-26	
				6-27	
				6-29	
				6-30	

* Denotes more than one day down time.

TABLE 6.1.3-1
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acetylene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/10			1				98,100		<1.5	<0.60	
1/10			2				98,100		<1.5	<0.60	
1/10			3				98,100		<1.5	<0.60	
AVERAGE							98,100		<1.5	<0.60	
2/4	14:00		1				71,900		<12	<3.5	
2/4	14:45		2				71,900		<12	<3.5	
2/4	15:00		3				71,900		<12	<3.5	
2/4	15:10		4				71,900		<12	<3.5	
2/6	13:10		6				71,900		<12	<3.5	
2/6	13:10		7				71,900		<12	<3.5	
2/6	13:20		8				71,900		<12	<3.5	
2/6	13:20		9				71,900		<12	<3.5	
2/6	13:30		10				71,900		<12	<3.5	
A V E R A G E							71,900		<12	<3.5	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-2
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acetylene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				80,300	1096	<0.5	<0.16	<0.00015
6/4	13:00	13:01	4				80,300	1074	<0.5	<0.16	<0.00015
6/4	15:19	15:20	7				80,300	952	<0.5	<0.16	<0.00017
6/12	16:36	16:37	10				80,300	1052	<0.5	<0.16	<0.00015
7/16	10:35	10:36	14				80,300	1029	<0.5	<0.16	<0.00016
7/16	12:03	12:04	17				80,300	1066	<0.5	<0.16	<0.00015
A V E R A G E							80,300	1045	<0.5	<0.16	<0.00016

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-3
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acetylene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				86,900	1096	<0.6	<0.21	<0.00019
6/4	13:00	13:01	4				86,900	1074	<0.5	<0.18	<0.00016
6/4	15:19	15:20	7				86,900	952	<0.5	<0.18	<0.00019
6/12	16:36	16:37	10				86,900	1052	<0.5	<0.18	<0.00017
7/16	10:35	10:36	14				86,900	1029	<0.5	<0.18	<0.00017
7/16	12:03	12:04	17				86,900	1066	<0.5	<0.18	<0.00017
AVERAGE							86,900	1045	<0.5	<0.18	<0.00018

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-4
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acridine

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.660	27.4	40	99,000		<0.11	<0.32	
1/16	14:24	14:54	2	<0.645	27.1	40	99,000		<0.11	<0.31	
A V E R A G E						40	99,000		<0.11	<0.32	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-5
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acridine

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.17	135	80,300	1097	<0.04	<0.09	<0.00008
6/12	10:37	11:15	2	<0.018	2.08	137	80,300	1079	<0.04	<0.09	<0.00008
6/12	15:10	16:24	3	<0.018	2.00	183	80,300	1053	<0.04	<0.10	<0.00009
AVERAGE						152	80,300	1076	<0.04	<0.09	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-6
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acridine

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.71	120	86,900	1097	<0.03	<0.08	<0.00007
6/12	10:37	11:15	2	<0.018	2.61	124	86,900	1079	<0.03	<0.08	<0.00007
6/12	15:10	16:24	3	<0.018	2.42	122	86,900	1053	<0.04	<0.09	<0.00009
AVERAGE						122	86,900	1076	<0.03	<0.08	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-7
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Acrolein

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.10	27.4	40	99,000		<0.06	<0.05	
1/16	14:24	14:54	2	<0.10	27.1	40	99,000		<0.06	<0.05	
A V E R A G E						40	99,000		<0.06	<0.05	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-8
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Filterable Acrolein / Total Acrolein

Stack: Scrubber Outlet Stack Diameter: 90"I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE ACROLEIN											
7/17	08:24	08:51	1	<0.022	2.81	120	86,900	1044	<0.12	<0.09	<0.000086
7/17	14:41	15:15	2	<0.023	2.67	126	86,900	1034	<0.13	<0.10	<0.000096
AVERAGE						123	86,900	1039	<0.12	<0.10	<0.000091
TOTAL ACROLEIN											
7/17	08:24	08:51	1	<0.094	2.81	120	86,900	1044	<0.51	<0.38	<0.00037
7/17	14:41	15:15	2	<0.085	2.67	126	86,900	1034	<0.48	<0.37	<0.00035
AVERAGE						123	86,900	1039	<0.50	<0.38	<0.00036

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-9
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Ammonia

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/6	11:25	12:25	1	0.043	53.8	34	71,900		0.04	0.008	
2/6	12:35	13:35	2	0.060	54.1	202	71,900		0.06	0.01	
2/6	14:00	15:00	3	<0.039	58.9	37	71,900		<0.03	<0.006	
AVERAGE						91	71,900		0.03-0.04	0.006-0.008	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-10
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Ammonia

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/3	10:40	11:05	1	<0.05	3.09		86,900	1018	<23	<5	<0.005
6/3	11:14	12:05	2	<0.04	3.05		86,900	1042	<18	<4	<0.004
AVERAGE							86,900	1030	<20	<4	<0.004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-11
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Anthracene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.581	27.4	40	99,000		<0.10	<0.28	
1/16	14:24	14:54	2	<0.568	27.1	40	99,000		<0.10	<0.27	
AVERAGE						40	99,000		<0.10	<0.28	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-12
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Anthracene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.17	135	80,300	1097	<0.04	<0.09	<0.00008
6/12	10:37	11:15	2	<0.018	2.08	137	80,300	1079	<0.04	<0.09	<0.00008
6/12	15:10	16:24	3	<0.018	2.00	183	80,300	1053	<0.04	<0.10	<0.00009
AVERAGE						152	80,300	1076	<0.04	<0.09	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-13
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Anthracene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.71	120	86,900	1097	<0.03	<0.08	<0.00007
6/12	10:37	11:15	2	<0.018	2.61	124	86,900	1079	<0.03	<0.08	<0.00007
6/12	15:10	16:24	3	<0.018	2.42	122	86,900	1053	<0.04	<0.09	<0.00009
A V E R A G E						122	86,900	1076	<0.03	<0.08	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-14
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Benzene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:26	12:27	1	0.003	1.22		80,300	1068	0.8	0.7	0.0007
6/5	12:50	12:51	3	0.007	1.21		80,300	1064	2	2	0.002
6/5	15:22	15:23	5	<0.001	1.22		80,300	1041	<0.2	<0.2	<0.0002
6/5	16:25	16:26	7	<0.001	1.22		80,300	1058	<0.2	<0.2	<0.0002
6/6	11:27	11:51	9	<0.001	3.60		80,300	1052	<0.09	<0.08	<0.00008
6/6	14:20	14:59	11	<0.001	3.59		80,300	1060	<0.09	<0.08	<0.00008
A V E R A G E							80,300	1057	0.5-0.6	0.4-0.5	0.0004-0.0005

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-15
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Benzene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:26	12:27	1	<0.001	1.00		86,900	1068	<0.3	<0.3	<0.0003
6/5	12:50	12:51	3	<0.001	0.99		86,900	1064	<0.3	<0.3	<0.0003
6/5	15:22	15:23	5	<0.001	0.99		86,900	1041	<0.3	<0.3	<0.0003
6/5	16:25	16:26	7	<0.001	1.00		86,900	1058	<0.3	<0.3	<0.0003
6/6	11:27	11:51	9	<0.001	2.98		86,900	1052	<0.1	<0.1	<0.0001
6/6	14:20	14:59	11	<0.001	3.00		86,900	1060	<0.1	<0.1	<0.0001
A V E R A G E							86,900	1057	<0.2	<0.2	<0.0002

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-16
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Benzene & Homologues

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/10			1				98,100		0.82	0.98	
1/10			2				98,100		3.6	4.2	
AVERAGE							98,100		2.2	2.6	
2/4	15:10		4	<0.033	0.703		71,900		<14.4	<12.7	
2/6	11:50		8	<0.043	0.753		71,900		<17.6	<15.4	
2/6	12:35		11	<0.048	0.774		71,900		<19.1	<16.7	
A V E R A G E							71,900		<17.0	<14.9	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-17
EMISSION TEST SUMMARY

Plant: Ford Motor Company -- Coke Battery Material: Benzene & Homologues

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:26	12:27	1	0.005	1.22		80,300	1068	1.3	1.2	0.0012
6/5	12:50	12:51	3	0.159	1.21		80,300	1064	40.4	39.6	0.0372
6/5	15:22	15:23	5	0.010	1.22		80,300	1041	2.5	2.5	0.0024
6/5	16:25	16:26	7	0.003	1.22		80,300	1058	0.76	0.74	0.00070
6/6	11:27	11:51	9	0.010	3.60		80,300	1052	0.85	0.84	0.00079
6/6	14:20	14:59	11	0.063	3.59		80,300	1060	5.4	5.3	0.0050
A V E R A G E							80,300	1057	8.5	8.4	0.0079

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-18
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Benzene & Homologues

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr	lb/ton of feed
6/5	12:26	12:27	1	0.025	1.00		86,900	1058	7.7	8.1	0.0076
6/5	12:50	12:51	3	0.034	0.99		86,900	1064	10.6	11.2	0.0105
6/5	15:22	15:23	5	0.005	0.99		86,900	1041	1.6	1.6	0.0016
6/5	16:25	16:26	7	0.007	1.00		86,900	1058	2.2	2.3	0.0022
6/6	11:27	11:51	9	0.007	2.98		86,900	1052	0.72	0.77	0.00073
6/6	14:20	14:59	11	0.003	3.00		86,900	1060	0.31	0.33	0.00031
AVERAGE							86,900	1057	3.9	4.0	0.0038

* Assuming continuous pushing

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TABLE 6.1.3-19
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Benzo(a+e)pyrene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.01	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.01	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.02	<0.05	<0.00005
AVERAGE						152	80,300	1076	<0.01	<0.05	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-20
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Benzo(a+e)pyrene

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.01	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.01	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.01	<0.04	<0.00004
A V E R A G E						122	86,900	1076	<0.01	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-21
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbazole

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<1.320	27.4	40	99,000		<0.24	<0.63	
1/16	14:24	14:54	2	<1.290	27.1	40	99,000		<0.24	<0.62	
AVERAGE						40	99,000		<0.24	<0.62	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-22
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbazole

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.17	135	80,300	1097	<0.04	<0.09	<0.00008
6/12	10:37	11:15	2	<0.018	2.08	137	80,300	1079	<0.04	<0.09	<0.00008
6/12	15:10	16:24	3	<0.018	2.00	183	80,300	1053	<0.05	<0.10	<0.00009
A V E R A G E						152	80,300	1076	<0.04	<0.09	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-23
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbazole

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.71	120	86,900	1097	<0.03	<0.08	<0.00007
6/12	10:37	11:15	2	<0.018	2.61	124	86,900	1079	<0.04	<0.08	<0.00007
6/12	15:10	16:24	3	<0.018	2.42	122	86,900	1053	<0.04	<0.09	<0.00009
AVERAGE						122	86,900	1076	<0.04	<0.08	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-24
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbon Disulfide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/4	15:25		5	<0.06	0.703		71,900		<27.0	<23.0	
2/6	11:50		9	<0.06	0.791		71,900		<24.0	<20.4	
2/6	12:48		12	<0.07	0.653		71,900		<33.9	<28.9	
A V E R A G E							71,900		<28.3	<24.1	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-25
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbon Disulfide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:40	12:41	2	<0.05	1.23		80,300	1060	<13	<12	<0.011
6/5	14:52	14:53	4	<0.05	1.22		80,300	1060	<13	<12	<0.011
6/5	16:14	16:15	6	<0.05	1.22		80,300	1058	<13	<12	<0.011
6/6	10:27	10:50	8	<0.05	2.38		80,300	1073	<7	<6	<0.006
6/6	13:38	14:11	10	<0.05	3.57		80,300	1001	<4	<4	<0.004
6/6	15:10	15:43	12	<0.05	3.59		80,300	1046	<4	<4	<0.004
AVERAGE							80,300	1050	<9	<8	<0.008

* Assuming continuous pushing

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TABLE 6.1.3-26
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbon Disulfide

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:40	12:41	2	<0.05	0.99		86,900	1060	<16	<16	<0.015
6/5	14:52	14:53	4	<0.05	0.98		86,900	1060	<16	<17	<0.016
6/5	16:14	16:15	6	<0.05	1.00		86,900	1058	<16	<16	<0.015
6/6	10:27	10:50	8	<0.05	1.99		86,900	1073	<8	<8	<0.007
6/6	13:38	14:11	10	<0.05	3.00		86,900	1001	<5	<5	<0.005
6/6	15:10	15:43	12	<0.05	2.97		86,900	1046	<5	<5	<0.005
A V E R A G E							86,900	1050	<11	<11	<0.010

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-27
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbon Monoxide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/4	14:00		1				71,900		20	6.3	
2/4	14:45		2				71,900		35	11.0	
2/4	15:00		3				71,900		15	4.7	
2/4	15:10		4				71,900		20	6.3	
2/6	13:10		6				71,900		<10	<3.1	
2/6	13:10		7				71,900		<10	<3.1	
2/6	13:20		8				71,900		<10	<3.1	
2/6	13:20		9				71,900		<10	<3.1	
2/6	13:30		10				71,900		<10	<3.1	
AVERAGE							71,900		10-16	3.1-4.9	

* Assuming continuous pushing

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TABLE 6.1.3-28
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Carbon Monoxide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	11:04	11:05	2				80,300	1100	65	23	0.021
6/4	13:10	13:11	5				80,300	1082	<10	<3.5	<0.0032
6/4	15:31	15:32	8				80,300	1053	<10	<3.5	<0.0033
6/12	16:51	16:52	11				80,300	1052	<10	<3.5	<0.0033
7/16	10:06	10:07	13				80,300	1014	98	34	0.034
7/16	11:37	11:38	16				80,300	1026	111	39	0.038
AVERAGE							80,300	1054	46-51	16-18	0.016-0.017

* Assuming continuous pushing

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TABLE 6.1.3-29
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Carbon Monoxide

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	11:04	11:05	2				86,900	1100	<10	<3.8	<0.0034
6/4	13:10	13:11	5				86,900	1082	<10	<3.8	<0.0035
6/4	15:31	15:32	8				86,900	1053	<10	<3.8	<0.0036
6/12	16:51	16:52	11				86,900	1052	<10	<3.8	<0.0036
7/16	10:06	10:07	13				86,900	1014	<60	<23	<0.022
7/16	11:37	11:38	16				86,900	1026	<60	<23	<0.022
A V E R A G E							86,900	1054	<30	<10	<0.010

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-30
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Chlorine

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/6	11:30	12:30	1	<0.0026	50.7	34	71,900		<0.0006	<0.0005	
2/6	12:38	13:38	2	0.0040	51.4	40	71,900		0.0009	0.0007	
2/6	14:03	15:03	3	0.0040	55.6	35	71,900		0.0009	0.0007	
2/14	11:18	12:18	1	0.0120	56.2	40	69,600		0.003	0.002	
2/14	12:20	13:20	2	<0.0040	57.0	42	69,600		<0.0008	<0.0006	
2/14	13:24	14:24	3	0.0058	56.5	46	69,600		0.001	0.0009	
A V E R A G E						40	70,800		0.001	0.0007-0.0009	

* Assuming continuous pushing

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TABLE 6.1.3-31
EMISSION TEST SUMMARY

Plant: Ford Motor Company-Coke Battery Material: Chlorine

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume @SCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
CHLORINE											
6/3	16:40	17:11	1	<0.003	2.95	120	86,900	1058	<0.01	<0.01	<0.000009
6/4	09:04	09:27	2	<0.003	2.69	117	86,900	1058	<0.01	<0.01	<0.000009
A V E R A G E						118	86,900	1.58	<0.01	<0.01	<0.000009

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-32
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Chrysene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1		27.4	40	99,000		<0.40	<1.4	
1/16	14:24	14:54	2		27.1	40	99,000		<0.39	<1.4	
A V E R A G E						40	99,000		<0.40	<1.4	

* Assuming continuous pushing

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TABLE 6.1.3-33
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Chrysene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.02	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.02	<0.05	<0.00005
A V E R A G E						152	80,300	1076	<0.02	<0.05	<0.00004

* Assuming continuous pushing

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TABLE 6.1.3-34
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Chrysene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.01	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.01	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.01	<0.04	<0.00004
AVERAGE						122	86,900	1076	<0.01	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-35
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Cyanide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
4/9	13:21	14:54	1	<0.00077	31.6		90,200		<0.02	<0.008	
4/9	15:03	15:06	2	0.0012	2.6		90,200		0.43	0.16	
4/10	13:51	14:44	3	<0.00078	33.8		89,900		<0.02	<0.008	
AVERAGE							90,000		0.14-0.16	0.05-0.06	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-36
EMISSION TEST SUMMARY

Plant: Ford Motor Company-Coke Battery

Material: Filterable Cyanide
Total Cyanide

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE CYANIDE											
6/3	16:40	17:11	1	0.029	2.95	120	86,900	1058	0.32	0.11	0.00010
6/4	14:58	15:20	5	0.048	2.88	120	86,900	1026	0.54	0.19	0.00019
AVERAGE						120	86,900	1042	0.43	0.15	0.00014
TOTAL CYANIDE											
6/3	16:40	17:11	1	0.176	2.95	120	86,900	1058	1.9	0.69	0.00065
6/4	14:58	15:20	5	0.177	2.88	120	86,900	1026	2.0	0.71	0.00069
AVERAGE						120	86,900	1042	2.0	0.70	0.00067
A V E R A G E											

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-37
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Ethylene & Homologues

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/10			1				98,100		<1.5	<0.64	
1/10			2				98,100		<1.5	<0.64	
1/10			3				98,100		<1.5	<0.64	
AVERAGE							98,100		<1.5	<0.64	
2/4	14:00		1				71,900		<12	<3.8	
2/4	14:45		2				71,900		<12	<3.8	
2/4	15:00		3				71,900		<12	<3.8	
2/4	15:10		4				71,900		<12	<3.8	
2/6	13:10		6				71,900		<12	<3.8	
2/6	13:10		7				71,900		<12	<3.8	
2/6	13:20		8				71,900		<12	<3.8	
2/6	13:20		9				71,900		<12	<3.8	
2/6	13:30		10				71,900		<12	<3.8	
A V E R A G E							71,900		<12	<3.8	

* Assuming continuous puching

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-38
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Ethylene & Homologues

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				80,300	1096	4	1	0.001
6/4	13:00	13:01	4				80,300	1074	15	5	0.005
6/4	15:19	15:20	7				80,300	952	1	0.3	0.0004
6/12	16:36	16:37	10				80,300	1052	<0.5	<0.2	<0.0002
7/16	10:35	10:36	14				80,300	1029	<0.5	<0.2	<0.0002
7/16	12:03	12:04	17				80,300	1066	184	64.5	0.0606
A V E R A G E							80,300	1045	34	12	0.011

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-39
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Ethylene & Homologues

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				86,900	1096	20	7	0.006
6/4	13:00	13:01	4				86,900	1074	1	0.4	0.0003
6/4	15:19	15:20	7				86,900	952	2	0.7	0.0007
6/12	16:36	16:37	10				86,900	1052	<0.5	<0.2	<0.0002
7/16	10:35	10:36	14				86,900	1029	2	0.7	0.0007
7/16	12:03	12:04	17				86,900	1066	0.5	0.2	0.0002
AVERAGE							86,900	1045	4.3	2	0.001

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-40
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Fluoranthene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.525	27.4	40	99,000		<0.08	<0.25	
1/16	14:24	14:54	2	<0.516	27.1	40	99,000		<0.08	<0.25	
AVERAGE						40	99,000		<0.08	<0.25	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-41
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Fluoranthene

Stack: Scrubber Inlet Stack Diameter: 66"I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.02	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.02	<0.05	<0.00005
AVERAGE						152	80,300	1076	<0.02	<0.05	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-42
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Fluoranthene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.01	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.01	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.02	<0.04	<0.00004
AVERAGE						122	86,900	1076	<0.01	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-43
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Fluorene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<1.460	27.4	40	99,000		<0.27	<0.70	
1/16	14:24	14:54	2	<1.428	27.1	40	99,000		<0.27	<0.69	
A V E R A G E						40	99,000		<0.27	<0.70	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-44
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Fluorene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.02	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.02	<0.05	<0.00005
A V E R A G E						152	80,300	1076	<0.02	<0.05	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-45
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Fluorene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.02	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.02	<0.04	<0.00004
AVERAGE						122	86,900	1076	<0.02	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-46
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: 9-Fluorenone

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.88	27.4	40	99,000		<0.15	<0.42	
1/16	14:24	14:54	2	<0.860	27.1	40	99,000		<0.15	<0.42	
A V E R A G E						40	99,000		<0.15	<0.42	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-47
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: 9-Fluorenone

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.02	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.02	<0.05	<0.00005
AVERAGE						152	80,300	1076	<0.02	<0.05	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-48
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: 9-Fluorenone

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.02	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.02	<0.04	<0.00004
AVERAGE						122	86,900	1076	<0.02	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-49
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Total Light Hydrocarbons (as Methane)

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/10			1				98,100		14.7	3.6	
1/10			2				98,100		5.3	1.3	
1/10			3				98,100		1.2	0.29	
AVERAGE							98,100		7.1	1.7	
2/4	14:00		1				71,900		VOID	VOID	
2/4	14:45		2				71,900		34	6.1	
2/4	15:00		3				71,900		70	12.6	
2/4	15:10		4				71,900		48	8.6	
2/6	13:10		6				71,900		48	8.6	
2/6	13:10		7				71,900		100	18.0	
2/6	13:20		8				71,900		123	22.1	
2/6	13:20		9				71,900		31	5.6	
2/6	13:30		10				71,900		32	5.8	
A V E R A G E							71,900		61	10.9	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-50
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Total Light Hydrocarbons (as Methane)

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				80,300	1096	40	8.0	0.0073
6/4	13:00	13:01	4				80,300	1074	30	6.0	0.0056
6/4	15:19	15:20	7				80,300	952	4	0.8	0.0008
6/12	16:36	16:37	10				80,300	1052	3	0.6	0.0006
7/16	10:35	10:36	14				80,300	1029	6	1	0.001
7/16	12:03	12:04	17				80,300	1066	514	103	0.0968
A V E R A G E							80,300	1045	100	20	0.019

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-51
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Total Light Hydrocarbons (as Methane)

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				86,900	1096	61	13	0.012
6/4	13:00	13:01	4				86,900	1074	17	3.7	0.0034
6/4	15:19	15:20	7				86,900	952	23	5.0	0.0053
6/12	16:36	16:37	10				86,900	1052	3	0.6	0.0006
7/16	10:35	10:36	14				86,900	1029	13	2.8	0.0027
7/16	12:03	12:04	17				86,900	1066	11	2.4	0.0022
AVERAGE							86,900	1045	21	4.6	0.0044

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-52
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Hydrogen Sulfide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
4/10	12:30	13:33	1	<0.02	33.4		89,900		<0.42	<0.20	
4/10	12:30	13:33	2	<0.02	33.6		89,900		<0.42	<0.20	
4/10	13:51	14:44	3	<0.02	32.9		89,900		<0.43	<0.20	
A V E R A G E							89,900		<0.42	<0.20	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-53
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Hydrogen Sulfide

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/3	10:40	11:05	1	<0.01	3.08		86,900	1018	<2	<1	<0.001
6/3	11:14	12:05	2	<0.01	3.06		86,900	1042	<2	<1	<0.001
AVERAGE							86,900	1030	<2	<1	<0.001

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-54
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Methane & Homologues

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/10			1				98,100		6.6	1.6	
1/10			2				98,100		5.3	1.3	
1/10			3				98,100		1.5	0.37	
AVERAGE							98,100		4.5	1.1	
2/4	14:00		1				71,900		15	2.7	
2/4	14:45		2				71,900		15	2.7	
2/4	15:00		3				71,900		14	2.5	
2/4	15:10		4				71,900		19	3.4	
2/6	13:10		6				71,900		14	2.5	
2/6	13:10		7				71,900		12	2.2	
2/6	13:20		8				71,900		17	3.1	
2/6	13:20		9				71,900		9.1	1.6	
2/6	13:30		10						10	1.8	
A V E R A G E							71,900		14	2.5	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-55
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Methane & Homologues

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				80,300	1096	6	1	0.001
6/4	13:00	13:01	4				80,300	1074	13	3	0.003
6/4	15:19	15:20	7				80,300	952	2	0.4	0.0004
6/12	16:36	16:37	10				80,300	1052	2	0.4	0.0004
7/16	10:35	10:36	14				80,300	1029	3	0.6	0.0006
7/16	12:03	12:04	17				80,300	1066	2	0.4	0.0004
A V E R A G E							80,300	1045	5	1	0.001

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-56
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Methane & Homologues

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/4	10:49	10:50	1				86,900	1096	13	3	0.003
6/4	13:00	13:01	4				86,900	1074	6	1	0.001
6/4	15:19	15:20	7				86,900	952	3	0.6	0.0006
6/12	16:36	16:37	10				86,900	1052	3	0.6	0.0006
7/16	10:35	10:36	14				86,900	1029	2	0.4	0.0004
7/16	12:03	12:04	17				86,900	1066	3	0.6	0.0006
A V E R A G E							86,900	1045	5	1	0.001

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-57
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Naphthalene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<4.4	27.4	40	99,000		<1.1	<2.1	
1/16	14:24	14:54	2	<4.3	27.1	40	99,000		<1.1	<2.1	
AVERAGE						40	99,000		<1.1	<2.1	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-58
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Naphthalene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.03	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.03	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.03	<0.05	<0.00005
A V E R A G E						152	80,300	1076	<0.03	<0.05	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-59
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Naphthalene

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.02	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.02	<0.04	<0.00004
AVERAGE						122	86,900	1076	<0.02	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-60
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Naphthalene
Total Naphthalene

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE NAPHTHALENE											
7/17	08:24	08:51	1	<0.023	2.81	120	86,900	1044	<0.05	<0.09	<0.000090
7/17	14:41	15:15	2	<0.024	2.67	126	86,900	1034	<0.06	<0.10	<0.00010
AVERAGE						123	86,900	1039	<0.06	<0.10	<0.00010
TOTAL NAPHTHALENE											
7/17	08:24	08:51	1	0.75	2.81	120	86,900	1044	1.8	3.1	0.0029
7/17	14:41	15:15	2	<0.089	2.67	126	86,900	1034	<0.22	<0.38	<0.00037
AVERAGE						123	86,900	1039	0.90-1.0	1.6-1.7	0.0014-0.0016

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

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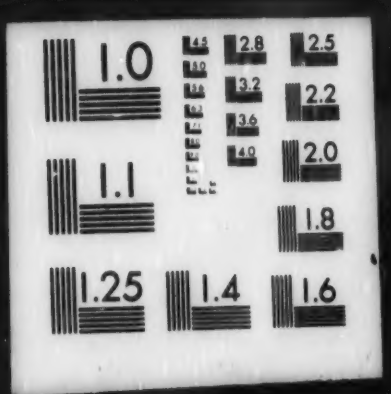


TABLE 6.1.3-61
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Nitrogen Oxides

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/4	13:05	13:06	1	0.076	1.72		71,900		23.1	11.9	
2/4	13:23	13:24	2	0.155	1.69		71,900		47.9	24.7	
2/4	13:30	13:31	3	0.050	1.87		71,900		14.0	7.2	
AVERAGE							71,900		28.3	14.6	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-62
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Nitrogen Oxides (as NO_2)

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/10	14:30	14:31	1	0.04	1.71		80,300	1101	12.2	7.0	0.0064
6/10	14:58	14:59	2	0.10	1.68		80,300	1054	31.1	17.9	0.0170
6/10	15:10	15:11	3	0.03	1.72		80,300	1053	9.1	5.2	0.0050
6/10	16:39	16:40	4	0.02	1.73		80,300	1054	6.0	3.5	0.0033
6/10	16:57	16:58	5	0.04	1.43		80,300	1054	14.6	8.4	0.0080
6/11	14:55	14:56	6	0.01	1.53		80,300	1071	3.4	2.0	0.0018
6/11	15:16	15:17	7	0.08	1.60		80,300	1082	26.1	15.0	0.0139
6/11	15:28	15:29	8	<0.01	1.60		80,300	1084	<3.3	<1.9	<0.0017
6/11	15:38	15:39	9	0.01	1.65		80,300	1059	3.2	1.8	0.0017
7/18	12:20	12:21	10	<0.01	1.72		80,300	1035	<3.0	<1.7	<0.0017
7/18	12:27	12:28	11	0.01	1.73		80,300	1040	3.0	1.7	0.0017
7/18	12:39	12:40	12	0.01	1.74		80,300	1032	3.0	1.7	0.0017
7/18	12:50	12:51	13	0.01	1.73		80,300	1041	3.0	1.7	0.0017
AVERAGE							80,300	1058	8.8 - 9.3	5.1 - 5.3	0.0048-0.0050

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-63
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Nitrogen Oxides (as NO_2)

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/10	14:30	14:31	1	0.07	1.76		86,900	1101	20.8	13.0	0.0118
6/10	14:58	14:59	2	0.12	1.81		86,900	1054	34.6	21.6	0.0205
6/10	15:10	15:11	3	0.03	1.81		86,900	1053	8.7	5.4	0.0051
6/10	16:39	16:40	4	0.03	1.82		86,900	1054	8.6	5.4	0.0051
6/10	16:57	16:58	5	0.23	1.80		86,900	1054	66.8	41.6	0.0395
6/11	14:55	14:56	6	0.03	1.82		86,900	1071	8.6	5.4	0.0050
6/11	15:16	15:17	7	0.17	1.82		86,900	1082	48.8	30.4	0.0281
6/11	15:28	15:29	8	0.01	1.84		86,900	1084	2.8	1.8	0.0016
6/11	15:38	15:39	9	0.01	1.84		86,900	1059	2.8	1.8	0.0017
7/18	12:20	12:21	10	<0.01	1.79		86,900	1035	<2.9	<1.8	<0.0018
7/18	12:27	12:28	11	0.01	1.65		86,900	1040	3.2	2.0	0.0019
7/18	12:39	12:40	12	0.02	1.80		86,900	1032	5.8	3.6	0.0035
7/18	12:50	12:51	13	0.07	1.76		86,900	1041	20.8	13.0	0.0124
AVERAGE							86,900	1058	17.9-18.1	11.2-11.3	0.0105-0.0106

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-64
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery

Material: Filterable Particulate
Condensible Particulate

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE PARTICULATE											
4/11	11:05	15:30	1	636.3	23.6	111	80,600		0.416	287	
4/14	13:16	17:29	2	996.8	24.6	98	90,000		0.625	482	
AVERAGE						104	85,300		0.520	384	
CONDENSIBLE PARTICULATE											
4/11	11:05	15:30	1	50.2	23.6	111	80,600		0.033	22.7	
4/14	13:16	17:29	2	25.1	24.6	98	90,000		0.016	12.1	
AVERAGE						104	85,300		0.024	17.4	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-65
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Particulate

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24	09:43	14:39	1	1883.7	16.3	158	82,800	1051	1.78	1270	1.20
6/25	10:05	14:29									
6/26	09:25	15:05	2	1646.9	16.3	183	79,700	1022	1.56	1070	1.04
6/27	10:56	14:25									
6/30	08:54	15:14									
7/1	08:51	09:36	3	2001.3	16.2	209	78,200	1028	1.91	1280	1.24
7/2	09:21	09:47									
7/2	13:27	15:46	4	1040.3	11.0	152	79,800	1052	1.46	998	0.949
7/3	08:38	10:28									
7/8	09:28	14:50	5	1325.5	11.3	137	81,700	1007	1.81	1270	1.26
7/10	09:40	15:06	6	1103.3	11.4	142	82,300	1038	1.49	1050	1.01
7/14	08:40	14:25	7	1347.6	11.4	130	81,800	981	1.82	1280	1.30
7/15	08:30	14:10	8	1197.4	11.1	143	79,400	1006	1.66	1130	1.13
7/16	08:24	13:49	9	1080.4	10.8	168	77,000	1035	1.54	1020	0.984
AVERAGE						158	80,300	1024	1.67	1150	1.12

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-66
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Particulate

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24	09:43	14:27	1	16.4	17.2	131	86,700	1051	0.015	10.9	0.0104
6/25	09:46	14:29									
6/26	09:25	15:05	2	14.2	17.9	127	87,800	1023	0.012	9.2	0.0090
6/27	10:40	14:25									
6/30	08:54	15:14									
7/1	08:51	09:36	3	15.1	17.9	126	86,300	1028	0.013	9.6	0.0094
7/2	09:21	09:47									
7/2	13:27	15:46	4	7.9	12.0	124	88,600	1052	0.010	7.7	0.0073
7/3	08:38	10:28									
7/8	09:28	14:50	5	8.4	12.5	131	88,800	1007	0.010	7.9	0.0078
7/10	09:40	15:06	6	9.4	11.9	124	85,200	1038	0.012	8.9	0.0086
7 /14	08:40	14:25	7	7.6	12.2	121	88,100	981	0.010	7.3	0.0074
7/15	08:30	14:10	8	4.7	11.8	124	85,700	1006	0.006	4.5	0.0045
7/16	08:24	13:49	9	6.1	11.4	123	85,000	1035	0.008	6.0	0.0058
AVERAGE						126	86,900	1025	0.011	8.0	0.0078

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-67
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery

Material: Condensible Particulate

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24	09:43	14:39	1	72.3	16.3	158	82,800	1051	0.068	48.6	0.0462
6/25	10:05	14:29									
6/26	09:25	15:05	2	29.1	16.3	183	79,700	1022	0.028	18.8	0.0184
6/27	10:56	14:25									
6/30	08:54	15:14									
7/1	08:51	09:36	3	69.3	16.2	209	78,200	1028	0.066	44.2	0.0430
7/2	09:21	09:47									
7/2	13:27	15:46	4	44.8	11.0	152	78,800	1052	0.063	42.4	0.0403
7/3	08:38	10:28									
7/8	09:28	14:50	5	30.9	11.3	137	81,700	1007	0.042	29.5	0.0293
7/10	09:40	15:06	6	41.9	11.4	142	82,300	1038	0.057	40.0	0.0385
7/14	08:40	14:25	7	46.6	11.4	130	81,800	981	0.063	44.2	0.0451
7/15	08:30	14:10	8	16.0	11.1	143	79,400	1006	0.022	15.1	0.0150
7/16	08:24	13:49	9	10.2	10.8	168	77,000	1035	0.015	9.6	0.0093
AVERAGE						158	80,300	1024	0.047	32.5	0.0317

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-68
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery Material: Condensible Particulate

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24	09:43	14:27	1	51.4	17.2	131	86,700	1051	0.046	34.3	0.0326
6/25	09:46	14:29									
6/26	09:25	15:05	2	37.3	17.9	127	87,800	1023	0.032	24.2	0.0237
6/27	10:40	14:25									
6/30	08:54	15:14									
7/1	08:51	09:36	3	39.8	17.9	126	86,300	1028	0.034	25.4	0.0247
7/2	09:21	09:47									
7/2	13:27	15:46	4	24.1	12.0	124	88,600	1052	0.031	23.5	0.0224
7/3	08:38	10:28									
7/8	09:28	14:50	5	7.8	12.5	131	88,800	1007	0.010	7.3	0.0073
7/10	09:40	15:06	6	10.8	11.9	124	85,200	1038	0.014	10.2	0.0099
7/14	08:40	14:25	7	4.4	12.2	121	88,100	981	0.006	4.2	0.0043
7/15	08:30	14:10	8	4.3	11.8	124	85,700	1006	0.006	4.1	0.0041
7/16	08:24	13:49	9	10.2	11.4	123	85,000	1035	0.014	10.1	0.0097
A V E R A G E						126	86,900	1025	0.021	15.9	0.0154

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-69
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery

Material: Filterable Chloroform-Ether Soluble Particulate.

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24 6/25	09:43 10:05	14:39 14:29	1	17.6	16.3	158	82,800	1051	0.017	11.8	0.0113
6/26 6/27	09:25 10:56	15:05 14:25	2	29.4	16.3	183	79,700	1022	0.028	19.0	0.0186
6/30 7/1 7/2	08:54 08:51 09:21	15:14 09:36 09:47	3	42.5	16.2	209	78,200	1028	0.040	27.1	0.0264
7/2 7/3	13:27 08:38	15:46 10:28	4	21.8	11.0	152	79,800	1052	0.031	20.9	0.0199
7/8	09:28	14:50	5	24.3	11.3	137	81,700	1007	0.033	23.2	0.0231
7/10	09:40	15:06	6	8.8	11.4	142	82,300	1038	0.012	8.4	0.0081
7/14	08:40	14:25	7	3.1	11.4	130	81,800	981	0.004	2.9	0.0030
7/15	08:30	14:10	8	2.2	11.1	143	79,400	1006	0.003	2.1	0.0021
7/16	08:24	13:49	9	4.2	10.8	168	77,000	1035	0.006	4.0	0.0038
AVERAGE						158	80,300	1024	0.019	13.3	0.0129

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-70
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery

Material: Filterable Chloroform-Ether Soluble Particulate

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24 6/25	09:43 09:46	14:27 14:29	1	0.9	17.2	131	86,700	1051	0.0008	0.60	0.0006
6/26 6/27	09:25 10:40	15:05 14:25	2	<0.5	17.9	127	87,800	1023	<0.0004	<0.32	<0.0003
6/30 7/1 7/2	08:54 08:51 09:21	15:14 09:36 09:47	3	1.3	17.9	126	86,300	1028	0.001	0.83	0.0008
7/2 7/3	13:27 08:38	15:46 10:28	4	0.9	12.0	124	88,600	1052	0.001	0.88	0.0008
7/8	09:28	14:50	5	<0.5	12.5	131	88,800	1007	<0.0006	<0.47	<0.0005
7/10	09:40	15:06	6	<0.5	11.9	124	85,200	1038	<0.0006	<0.47	<0.0005
7/14	08:40	14:25	7	<0.5	12.2	121	88,180	981	<0.0006	<0.48	<0.0005
7/15	08:30	14:10	8	0.7	11.8	124	85,700	1006	0.0009	0.67	0.0007
7/16	08:24	13:49	9	1.9	11.4	123	85,000	1035	0.003	1.9	0.0018
AVERAGE						126	86,900	1025	0.0007 -0.001	0.54 -0.74	0.0005 -0.0007

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-71
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery

Material: Condensible Chloroform - Ether Soluble Particulate

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24	09:43	14:39	1	7.4	16.3	158	82,800	1051	0.007	5.0	0.0047
6/25	10:05	14:29									
6/26	09:25	15:05	2	<0.5	16.3	183	79,700	1022	<0.0005	<0.32	<0.0003
6/27	10:56	14:25									
6/30	08:54	15:14									
7/1	08:51	09:36	3	4.8	16.2	209	78,200	1028	0.005	3.1	0.0030
7/2	09:21	09:47									
7/2	13:27	15:46	4	0.9	11.0	152	79,800	1052	0.001	0.86	0.0008
7/3	08:38	10:28									
7/8	09:28	14:50	5	2.6	11.3	137	81,700	1007	0.004	2.5	0.0025
7/10	09:40	15:06	6	3.3	11.4	142	82,300	1038	0.004	3.2	0.0030
7/14	08:40	14:25	7	7.3	11.4	130	81,800	981	0.010	6.9	0.0071
7/15	08:30	14:10	8	4.7	11.1	143	79,400	1006	0.007	4.4	0.0044
7/16	08:24	13:49	9	2.8	10.8	168	77,000	1035	0.004	2.6	0.0026
AVERAGE						158	80,300	1024	0.005	3.2	0.003 - 0.0032

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-72
EMISSION TEST SUMMARY

Plant: Ford Motor Company - Coke Battery

Material: Condensible Chloroform - Ether Soluble Particulate

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (gr/DSCF)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/24	09:43	14:27	1	10.3	17.2	131	86,700	1051	0.009	6.9	0.0065
6/25	09:46	14:29									
6/26	09:25	15:05	2	1.5	17.9	127	87,800	1023	0.001	0.97	0.0010
6/27	10:40	14:25									
6/30	08:54	15:14									
7/1	08:51	09:36	3	2.7	17.9	126	86,300	1028	0.002	1.7	0.0017
7/2	09:21	09:47									
7/2	13:27	15:46	4	2.8	12.0	124	88,600	1052	0.004	2.7	0.0026
7/3	08:38	10:28									
7/8	09:28	14:50	5	1.6	12.5	131	88,800	1007	0.002	1.5	0.0015
7/10	09:40	15:06	6	<0.5	11.9	124	85,200	1038	<0.0006	<0.47	<0.0005
7/14	08:40	14:25	7	0.6	12.2	121	88,100	981	0.0008	0.57	0.0006
7/15	08:30	14:10	8	2.7	11.8	124	85,700	1006	0.004	2.6	0.0026
7/16	08:24	13:49	9	3.7	11.4	123	85,000	1035	0.005	3.6	0.0035
AVERAGE						126	86,900	1025	0.003	2.3	0.0022-0.0023

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-73
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Phenanthrene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.660	27.4	40	99,000		<0.11	<0.32	
1/16	14:24	14:54	2	<0.645	27.1	40	99,000		<0.11	<0.31	
AVERAGE						40	99,000		<0.11	<0.32	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-74
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Phenanthrene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.17	135	80,300	1097	<0.04	<0.09	<0.00008
6/12	10:37	11:15	2	<0.018	2.08	137	80,300	1079	<0.04	<0.09	<0.00008
6/12	15:10	16:24	3	<0.018	2.00	183	80,300	1053	<0.04	<0.10	<0.00009
AVERAGE						152	80,300	1076	<0.04	<0.09	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-75
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Phenanthrene

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.018	2.71	120	86,900	1097	<0.03	<0.08	<0.00007
6/12	10:37	11:15	2	<0.018	2.61	124	86,900	1079	<0.03	<0.08	<0.00007
6/12	15:10	16:24	3	<0.018	2.42	122	86,900	1053	<0.04	<0.09	<0.00009
AVERAGE						122	86,900	1076	<0.03	<0.08	<0.00008

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-76
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Phenol

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/6	11:30	12:30	1	<0.0077	50.7	34	71,900		<0.001	<0.001	
2/6	12:38	13:38	2	<0.0088	51.4	40	71,900		<0.002	<0.002	
2/6	14:03	15:03	3	<0.0090	55.6	35	71,900		<0.001	<0.002	
2/14	11:18	12:18	1	0.0305	56.2	40	69,600		0.005	0.005	
2/14	12:20	13:20	2	0.0078	57.0	42	69,600		0.001	0.001	
2/14	13:24	14:24	3	0.0290	56.5	46	69,600		0.005	0.005	
AVERAGE						40	70,800		0.002	0.002-0.003	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-77
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Phenolics
Total Phenolics

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE PHENOLICS											
6/3	16:40	17:11	1	<0.23	2.03	163	80,300	1058	<1.0	<1.2	<0.0011
6/4	09:04	09:27	2	<0.12	2.10	135	80,300	1058	<0.52	<0.61	<0.00057
6/4	10:49	11:17	3	<0.13	2.29	155	80,300	1092	<0.51	<0.60	<0.00055
6/4	13:00	13:18	4	<0.12	2.10	134	80,300	1070	<0.52	<0.61	<0.00057
6/4	14:58	15:20	5	<0.14	2.17	138	80,300	1026	<0.58	<0.69	<0.00067
6/5	12:26	12:51	6	<0.15	2.20	128	80,300	1064	<0.61	<0.72	<0.00068
AVERAGE						142	80,300	1061	<0.62	<0.74	<0.00069
TOTAL PHENOLICS											
6/3	16:40	17:11	1	<0.33	2.03	163	80,300	1058	<1.5	<1.7	<0.0016
6/4	09:04	09:27	2	<0.22	2.10	135	80,300	1058	<0.94	<1.1	<0.0011
6/4	10:49	11:17	3	<0.23	2.29	155	80,300	1092	<0.91	<1.1	<0.00098
6/4	13:00	13:18	4	<0.22	2.10	134	80,300	1070	<0.94	<1.1	<0.0010
6/4	14:58	15:20	5	<0.24	2.17	138	80,300	1026	<1.0	<1.2	<0.0011
6/5	12:26	12:51	6	<0.25	2.20	128	80,300	1064	<1.0	<1.2	<0.0011
AVERAGE						142	80,300	1061	<1.0	<1.2	<0.0011

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-78
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Phenolics
Total Phenolics

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE PHENOLICS											
6/3	16:40	17:11	1	<0.12	2.95	120	86,900	1058	<0.37	<0.47	<0.00044
6/4	09:04	09:27	2	<0.11	2.69	117	86,900	1058	<0.37	<0.47	<0.00044
6/4	10:49	11:17	3	<0.12	2.90	118	86,900	1092	<0.37	<0.48	<0.00044
6/4	13:00	13:18	4	<0.11	2.83	120	86,900	1070	<0.35	<0.45	<0.00042
6/4	14:58	15:20	5	<0.12	2.88	120	86,900	1026	<0.38	<0.48	<0.00047
6/5	12:26	12:51	6	<0.11	2.83	122	86,900	1064	<0.35	<0.45	<0.00042
AVERAGE						120	86,900	1061	<0.36	<0.47	<0.00044
TOTAL PHENOLICS											
6/3	16:40	17:11	1	<0.22	2.95	120	86,900	1058	<0.67	<0.86	<0.00081
6/4	09:04	09:27	2	<0.21	2.69	117	86,900	1058	<0.70	<0.90	<0.00085
6/4	10:49	11:17	3	<0.22	2.90	118	86,900	1092	<0.68	<0.87	<0.00080
6/4	13:00	13:18	4	<0.21	2.83	120	86,900	1070	<0.67	<0.85	<0.00080
6/4	14:58	15:20	5	<0.22	2.88	120	86,900	1026	<0.69	<0.88	<0.00086
6/5	12:26	12:51	6	<0.21	2.83	122	86,900	1064	<0.67	<0.85	<0.00080
A V E R A G E						120	86,900	1061	<0.68	<0.87	<0.00082

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-79
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Pyrene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
1/16	13:53	14:23	1	<0.440	27.4	40	99,000		<0.07	<0.21	
1/16	14:24	14:54	2	<0.430	27.1	40	99,000		<0.07	<0.21	
AVERAGE						40	99,000		<0.07	<0.21	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-80
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Pyrene

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.17	135	80,300	1097	<0.02	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.08	137	80,300	1079	<0.02	<0.05	<0.00004
6/12	15:10	16:24	3	<0.009	2.00	183	80,300	1053	<0.02	<0.05	<0.00005
AVERAGE						152	80,300	1076	<0.02	<0.05	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-81
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Pyrene

Stack: Scrubber Outlet Stack Diameter: 90"I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/11	13:47	14:24	1	<0.009	2.71	120	86,900	1097	<0.01	<0.04	<0.00004
6/12	10:37	11:15	2	<0.009	2.61	124	86,900	1079	<0.01	<0.04	<0.00004
6/12	15:10	16:24	3	<0.009	2.42	122	86,900	1053	<0.02	<0.04	<0.00004
AVERAGE						122	86,900	1076	<0.01	<0.04	<0.00004

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-82
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Pyridine

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/4	15:25		5	<0.005	0.703		71,900		<2.2	<1.9	
2/6	11:50		9	<0.005	0.791		71,900		<1.9	<1.7	
2/6	12:48		12	<0.006	0.653		71,900		<2.8	<2.5	
A V E R A G E							71,900		<2.3	<2.0	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-83
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Pyridine

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:26	12:27	1	<0.001	1.22		80,300	1068	<0.2	<0.2	<0.0002
6/5	12:50	12:51	3	<0.001	1.21		80,300	1064	<0.2	<0.2	<0.0002
6/5	15:22	15:23	5	<0.001	1.22		80,300	1041	<0.2	<0.2	<0.0002
6/5	16:25	16:26	7	<0.001	1.22		80,300	1058	<0.2	<0.2	<0.0002
6/6	11:27	11:51	9	<0.001	3.60		80,300	1052	<0.08	<0.08	<0.00008
6/6	14:20	14:59	11	<0.001	3.59		80,300	1060	<0.08	<0.08	<0.00008
AVERAGE							80,300	1057	<0.2	<0.2	<0.0002

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-84
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Pyridine

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (liters)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	12:26	12:27	1	<0.001	1.00		86,900	1068	<0.3	<0.3	<0.0003
6/5	12:50	12:51	3	<0.001	0.99		86,900	1064	<0.3	<0.3	<0.0003
6/5	15:22	15:23	5	<0.001	0.99		86,900	1041	<0.3	<0.3	<0.0003
6/5	16:25	16:26	7	<0.001	1.00		86,900	1058	<0.3	<0.3	<0.0003
6/6	11:27	11:51	9	<0.001	2.98		86,900	1052	<0.1	<0.1	<0.0001
6/6	14:20	14:59	11	<0.001	3.00		86,900	1060	<0.1	<0.1	<0.0001
AVERAGE							86,900	1057	<0.2	<0.2	<0.0002

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-85
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Sulfur Dioxide

Stack: Scrubber Inlet Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/12	11:16	12:16	1	3.72	46.8	45	69,600		1.1	0.73	
2/12	12:18	13:18	2	6.85	46.4	42	69,600		2.0	1.4	
2/12	13:28	14:28	3	10.6	45.9	44	69,600		3.1	2.1	
AVERAGE						44	69,600		2.1	1.4	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-86
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Sulfur Dioxide

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	15:02	16:26	1	3.11	3.74	148	80,300	1053	11.0	8.8	0.0084
6/6	10:04	10:50	2	2.15	2.85	139	80,300	1069	10.0	8.0	0.0075
6/6	11:27	11:51	3	1.98	2.79	130	80,300	1052	9.4	7.5	0.0072
6/6	13:38	14:11	4	2.40	2.81	140	80,300	1001	11.3	9.1	0.0091
6/6	14:58	15:23	5	2.66	2.82	160	80,300	1057	12.5	10.0	0.0095
6/9	10:58	11:29	6	3.11	2.73	165	80,300	1038	15.1	12.1	0.0117
6/9	13:35	14:04	7	2.53	2.80	154	80,300	1050	12.0	9.6	0.0091
6/9	14:32	15:03	8	1.57	2.79	179	80,300	1039	7.5	6.0	0.0058
6/10	09:33	10:15	9	3.36	2.86	165	80,300	1060	15.6	12.5	0.0118
AVERAGE						153	80,300	1047	11.6	9.3	0.0089

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-87
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery Material: Sulfur Dioxide

Stack: Scrubber Outlet Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	15:02	16:26	1	1.47	3.72	126	86,900	1053	5.2	4.5	0.0043
6/6	10:04	10:50	2	0.90	2.79	117	86,900	1069	4.3	3.7	0.0035
6/6	11:27	11:51	3	0.90	3.04	120	86,900	1052	3.9	3.4	0.0032
6/6	13:38	14:11	4	1.12	2.83	120	86,900	1001	5.2	4.6	0.0045
6/6	14:58	15:23	5	0.90	2.79	120	86,900	1057	4.3	3.7	0.0035
6/9	10:58	11:29	6	1.51	1.78	126	86,900	1038	11.2	9.8	0.0094
6/9	13:22	14:04	7	1.15	2.87	125	86,900	1049	5.3	4.6	0.0044
6/9	14:32	15:03	8	1.82	2.80	129	86,900	1039	8.6	7.5	0.0072
6/10	09:33	10:15	9	1.98	2.91	128	86,900	1060	9.0	7.8	0.0074
AVERAGE						123	86,900	1046	6.3	5.5	0.0053

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-88
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Sulfur Trioxide

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
2/12	11:16	12:16	1	0.681	46.8	45	69,600		0.15	0.13	
2/12	12:18	13:18	2	<0.280	46.4	42	69,600		<0.06	<0.06	
2/12	13:28	14:28	3	1.20	45.9	44	69,600		0.28	0.24	
A V E R A G E						44	69,600		0.14-0.16	0.12-0.14	

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-89
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Sulfur Trioxide

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	15:02	16:26	1	<0.16	3.74	148	80,300	1053	<0.45	<0.45	<0.00043
6/6	10:04	10:50	2	0.24	2.85	139	80,300	1069	0.89	0.89	0.00084
6/6	11:27	11:51	3	<0.12	2.79	130	80,300	1052	<0.46	<0.46	<0.00043
6/6	13:38	14:11	4	<0.12	2.81	140	80,300	1001	<0.45	<0.45	<0.00045
6/6	14:58	15:23	5	<0.12	2.82	160	80,300	1057	<0.45	<0.45	<0.00043
6/9	10:58	11:29	6	<0.48	2.73	165	80,300	1038	<1.9	<1.9	<0.0018
6/9	13:35	14:04	7	<0.20	2.80	154	80,300	1050	<0.76	<0.76	<0.00072
6/9	14:32	15:03	8	2.40	2.79	179	80,300	1039	9.1	9.1	0.0088
6/10	09:33	10:15	9	<0.20	2.86	165	80,300	1060	<0.74	<0.74	<0.00070
AVERAGE						153	80,300	1047	1.1-1.7	1.1-1.7	0.0011 0.0016

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-90
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Sulfur Trioxide

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate * (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
6/5	15:02	16:26	1	<0.20	3.72	126	86,900	1053	<0.57	<0.62	<0.00059
6/6	10:04	10:50	2	<0.16	2.79	117	86,900	1069	<0.61	<0.66	<0.00062
6/6	11:27	11:51	3	<0.16	3.04	120	86,900	1052	<0.56	<0.61	<0.00058
6/6	13:38	14:11	4	<0.32	2.83	120	86,900	1001	<1.2	<1.3	<0.0013
6/6	14:58	15:23	5	0.64	2.79	120	86,900	1057	2.4	2.6	0.0025
6/9	10:58	11:29	6	<0.24	1.78	126	86,900	1038	<1.4	<1.6	<0.0015
6/9	13:22	14:04	7	<.020	2.87	125	86,900	1049	<0.74	<0.80	<0.00076
6/9	14:32	15:03	8	<0.20	2.80	129	86,900	1039	<0.76	<0.82	<0.00079
6/10	09:33	10:15	9	<0.24	2.91	128	86,900	1060	<0.88	<0.95	<0.00089
AVERAGE						123	86,900	1046	0.27-1.0	0.29-1.1	0.0003-0.0011

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-91
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Sulfur Oxides (as sulfate)
Total Sulfur Oxides (as sulfate)

Stack: Scrubber Inlet

Stack Diameter: 66" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE SULFUR OXIDES (AS SULFATE)											
6/3	16:40	17:11	1	26.6	2.03	163	80,300	1058	11.6	139	0.131
6/4	09:04	09:27	2	10.5	2.10	135	80,300	1058	44.2	53.1	0.0502
6/4	10:49	11:17	3	2.9	2.29	155	80,300	1092	11.2	13.5	0.0123
6/4	13:00	13:18	4	2.6	2.10	134	80,300	1070	10.9	13.2	0.0123
6/4	14:58	15:20	5	4.7	2.17	138	80,300	1026	19.1	23.0	0.0224
6/5	12:26	12:51	6	6.8	2.20	128	80,300	1064	27.3	32.9	0.0309
AVERAGE						142	80,300	1061	38.1	45.8	0.0432
TOTAL SULFUR OXIDES (AS SULFATE)											
6/3	16:40	17:11	1	46.2	2.03	163	80,300	1058	201	242	0.229
6/4	09:04	09:27	2	17.9	2.10	135	80,300	1058	75.3	90.6	0.0856
6/4	10:49	11:17	3	8.3	2.29	155	80,300	1092	32.0	38.5	0.0353
6/4	13:00	13:18	4	8.8	2.10	134	80,300	1070	37.0	44.5	0.0416
6/4	14:58	15:20	5	12.3	2.17	138	80,300	1026	50.1	60.2	0.0587
6/5	12:26	12:51	6	12.4	2.20	128	80,300	1064	49.8	59.9	0.0563
A V E R A G E						142	80,300	1061	74.2	89.3	0.0844

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.3-92
EMISSION TEST SUMMARY

Plant: Ford Motor Company--Coke Battery

Material: Filterable Sulfur Oxides (as Sulfate)
Total Sulfur Oxides (as Sulfate)

Stack: Scrubber Outlet

Stack Diameter: 90" I.D.

1975 Date	Sampling Period		Test No.	Sample Weight (mg)	Sampled Volume (DSCF)	Stack Temp. (°F)	Stack Gas Flowrate (DSCFM)	Feed Rate* (tons/hr)	Concentration (ppm)	Emission Rate	
	Start	Stop								lb/hr*	lb/ton of feed
FILTERABLE SULFUR OXIDES (as sulfate)											
6/3	16:40	17:11	1	0.76	2.95	120	86,900	1058	2.3	3.0	0.0028
6/4	09:04	09:27	2	1.0	2.69	117	86,900	1058	3.3	4.3	0.0040
6/4	10:49	11:17	3	1.2	2.90	118	86,900	1092	3.7	4.8	0.0044
6/4	13:00	13:18	4	0.46	2.83	120	86,900	1070	1.4	1.9	0.0017
6/4	14:58	15:20	5	1.9	2.88	120	86,900	1026	5.8	7.6	0.0074
6/5	12:26	12:51	6	1.2	2.83	122	86,900	1064	3.7	4.9	0.0046
AVERAGE						120	86,900	1061	3.4	4.4	0.0042
TOTAL SULFUR OXIDES (as sulfate)											
6/3	16:40	17:11	1	15.96	2.95	120	86,900	1058	47.8	62.2	0.0588
6/4	09:04	09:27	2	4.2	2.69	117	86,900	1058	13.8	18.0	0.0170
6/4	10:49	11:17	3	3.3	2.90	118	86,900	1092	10.1	13.1	0.0120
6/4	13:00	13:18	4	5.46	2.83	120	86,900	1070	17.0	22.2	0.0207
6/4	14:58	15:20	5	8.8	2.88	120	86,900	1026	27.0	35.1	0.0343
6/5	12:26	12:51	6	6.4	2.83	122	86,900	1064	20.0	26.0	0.0244
A V E R A G E						120	86,900	1061	22.6	29.4	0.0279

* Assuming continuous pushing

Clayton Environmental Consultants, Inc.

TABLE 6.1.4-1
SUMMARY OF FUGITIVE EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

1975 Date	Push Time	Oven No.	Concentration (mg/m^3)	Process Condition	Average Greenness
6-10	1315	42	123	3	2.0
6-10	1330	X52	179	3	2.3
6-10	1350	4	24.8	3	2.0
6-10	1419	24	66.6	3	1.4
6-10	1458	44	284	3	3.0
6-10	1510	X54	29.4	3	1.2
6-11	0905	16	254	3	2.5
6-11	0938	26	78.4	3	1.3
6-11	1000	36	273	3	3.0
6-11	1423	X61	35.1*	3	2.6
6-11	1445	13	136	3	2.3
6-11	1455	23	77.6*	3	1.0
6-11	1516	43	632	3	3.0
6-12	1410	32	13.9*	3	1.8
6-12	1418	42	46.0	3	1.0
6-12	1434	X52	23.8	3	1.0
6-12	1510	14	37.2	3	1.0
6-12	1521	24	63.7	3	1.2
6-13	1115	28	576	1	3.0
6-13	1129	38	105	1	3.0
6-13	1325	31	38.3*	1	1.5
6-13	1341	41	290	1	2.5
6-13	1404	X51	141	1	2.5
6-13	1438	13	493*	1	3.0
6-13	1452	23	102*	1	2.3
6-13	1512	33	143	1	1.5
6-13	1536	43	73.6	1	2.5
6-16	0930	43	47.1	2	1.0
6-16	0940	X53	150	2	1.0
6-16	1015	X63	243	2	2.3
6-16	1027	5	456	2	3.0
6-16	1039	15	202	2	2.8
6-16	1050	25	221	2	2.5
6-16	1101	35	154	2	1.7
6-16	1110	45	398	2	3.0
6-16	1123	X55	379	2	2.3
6-16	1130	7	427	2	2.8
6-16	1330	9	375	1	1.3
6-16	1352	19	195	1	1.3
6-16	1402	29	61.3	1	1.5

* Outlier according to methods presented in Section 6.3.

Clayton Environmental Consultants, Inc.

TABLE 6.1.4-2
SUMMARY OF FUGITIVE EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

1975 Date	Push Time	Oven No.	Concentration (mg/m^3)	Process Condition	Average Greenness
6-16	1427	49	673	1	3.0
6-16	1452	X59	177	1	1.3
6-16	1504	2	497	2	2.0
6-16	1514	12	44.2	2	1.0
6-16	1525	22	42.5	2	1.0
6-16	1534	32	239	2	1.3
6-17	0950	X62	292	1	3.0
6-17	1003	4	516	1	3.0
6-17	1016	14	572	1	2.3
6-17	1031	24	615	1	2.0
6-17	1047	34	196	1	2.5
6-17	1104	44	482	1	3.0
6-17	1238	16	441	2	2.5
6-17	1408	8	472	2	2.5
6-17	1416	18	330	2	2.5
6-17	1425	28	527	2	2.3
6-17	1435	38	600*	2	2.0
6-17	1447	48	339	2	2.0
6-17	1459	X58	235	2	1.8
6-17	1510	1	109*	2	2.0
6-17	1521	11	426*	2	2.3
6-17	1528	21	486	2	2.3
6-17	1538	31	585	2	2.7
6-17	1550	41	996*	2	2.5
6-18	0942	23	776	2	2.8
6-18	0950	33	313	2	2.8
6-18	1006	43	355	2	1.8
6-18	1025	X53	54.2*	2	2.0
6-18	1037	X63	276	2	2.0
6-18	1048	5	886	2	3.0
6-18	1100	15	380	2	3.0
6-18	1111	25	298	2	2.0
6-18	1124	35	429	2	2.8
6-18	1300	27	834	2	2.6
6-18	1313	37	850	2	3.0
6-18	1333	47	184	2	3.0
6-18	1344	X57	30.9*	2	2.5
6-18	1350	9	316	2	2.2
6-18	1410	19	93.0	2	2.5
6-18	1422	29	501	2	3.0
6-18	1436	39	256	2	1.8

* Outlier according to methods presented in Section 6.3.

Clayton Environmental Consultants, Inc.

TABLE 6.1.4-3
SUMMARY OF FUGITIVE EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

1975 Date	Push Time	Oven No.	Concentration (mg/m^3)	Process Condition	Average Greenness
6-18	1447	49	184*	2	2.6
6-18	1507	X59	40.7*	2	3.0
6-18	1518	2	269*	2	2.5
6-19	1000	42	210	2	2.0
6-19	1014	X52	237*	2	2.3
6-19	1025	X62	192	2	1.7
6-19	1039	4	281	2	2.3
6-19	1050	14	595	2	2.5
6-19	1100	24	140	2	1.5
6-19	1107	34	504	2	3.0
6-19	1127	44	569	2	3.0
6-19	1317	46	264	2	2.5
6-19	1330	X56	331	2	2.5
6-19	1345	8	496	2	2.7
6-19	1359	18	358	2	3.0
6-19	1406	28	429	2	2.7
6-19	1420	38	341	2	2.7
6-19	1444	48	457	2	2.8
6-19	1500	X58	236	2	2.7
6-19	1512	1	121*	2	2.0
6-19	1522	11	443	2	3.0
6-20	0926	X51	75.4*	2	2.2
6-20	0935	X61	62.5*	2	2.5
6-20	0953	3	556	2	3.0
6-20	1005	13	269	2	2.0
6-20	1017	23	561	2	2.6
6-20	1032	33	589	2	3.0
6-20	1045	43	160	2	1.4
6-20	1107	X53	154	2	2.0
6-20	1115	X63	345	2	2.3
6-20	1125	5	768	2	3.0
6-20	1137	15	544	2	2.8
6-20	1148	25	219	2	1.8
6-20	1345	17	476	1	3.0
6-20	1358	27	297	1	3.0
6-20	1413	37	385	1	2.2
6-20	1434	47	613	1	2.4
6-20	1449	X57	294	1	1.8
6-20	1500	9	636	1	1.6
6-20	1510	19	345	1	2.0
6-20	1520	29	485	1	3.0

* Outlier according to methods presented in Section 6.3.

Clayton Environmental Consultants, Inc.

TABLE 6.1.4-4
SUMMARY OF FUGITIVE EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

1975 Date	Push Time	Oven No.	Concentration (mg/m^3)	Process Condition	Average Greenness
6-23	0905	39	296	2	2.3
6-23	0934	49	164	2	2.3
6-23	0956	X59	105	2	1.5
6-23	1012	2	330 *	2	2.7
6-23	1049	22	369	1	1.5
6-23	1057	32	675	1	2.0
6-23	1110	42	577	1	2.5
6-23	1128	X52	327	1	1.3
6-23	1152	X62	96.8	1	1.3
6-23	1200	4	369	1	3.0
6-23	1313	44	54.3	1	2.3
6-23	1330	X54	104	1	1.3
6-23	1345	X64	200	1	2.0
6-23	1358	6	268	1	1.5
6-24	0921	X58	707	1	2.7
6-24	0943	1	143 *	2	2.5
6-24	1013	11	221	2	2.0
6-24	1025	21	168	2	1.6
6-24	1036	31	487	3	3.0
6-24	1052	41	63.9	3	1.2
6-24	1103	X51	44.1	3	1.0
6-24	1117	X61	90.5 *	3	1.0
6-24	1132	3	99.9	3	2.4
6-24	1330	X53	33.2	3	1.3
6-24	1340	X63	197	3	2.2
6-24	1348	5	345	3	2.6
6-25	0912	9	547	3	3.0
6-25	0946	19	221	3	3.0
6-25	0955	29	500	3	3.0
6-25	1005	39	150	3	1.8
6-25	1018	49	152	3	2.3
6-25	1029	X59	63.2	3	1.0
6-25	1040	2	84.5 *	3	3.0
6-25	1053	12	59.1	3	2.0
6-25	1105	22	501 *	3	3.0
6-25	1120	32	453 *	3	3.0
6-25	1133	42	188	3	1.8
6-25	1255	14	390 *	3	2.3
6-25	1310	24	428	3	2.6
6-25	1332	34	146 *	3	2.2
6-25	1342	44	73.9	3	1.6
6-25	1353	X54	33.2	3	1.2

* Outlier according to methods presented in Section 6.3.

Clayton Environmental Consultants, Inc.

TABLE 6.1.4-5
SUMMARY OF FUGITIVE EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

1975 Date	Push Time	Oven No.	Concentration (mg/m^3)	Process Condition	Average Greenness
6-25	1403	X64	154	3	2.5
6-25	1417	6	78.5	3	2.3
6-25	1428	16	548	3	3.0
6-25	1438	26	54.2	3	2.0
6-25	1454	36	126	3	1.4
6-26	0846	18	563	3	3.0
6-26	0900	28	826	3	3.0
6-26	0915	38	138	3	1.8
6-26	0925	48	356	3	3.0
6-26	0937	X58	32.6	3	1.0
6-26	1016	1	181*	3	2.8
6-26	1022	11	224*	3	2.6
6-26	1039	21	129	3	2.0
6-26	1049	31	283	3	2.6
6-26	1102	41	58.0*	3	1.2
6-26	1125	X51	37.3	3	1.0
6-26	1345	X63	59.4	3	1.0
6-26	1355	5	320	2	3.0
6-26	1408	15	129*	2	2.4
6-26	1428	25	123	2	1.8
6-26	1438	35	173*	2	2.8
6-26	1458	45	277*	3	2.8
6-26	1504	X55	16.7*	3	1.6

* Outlier according to methods presented in Section 6.3.

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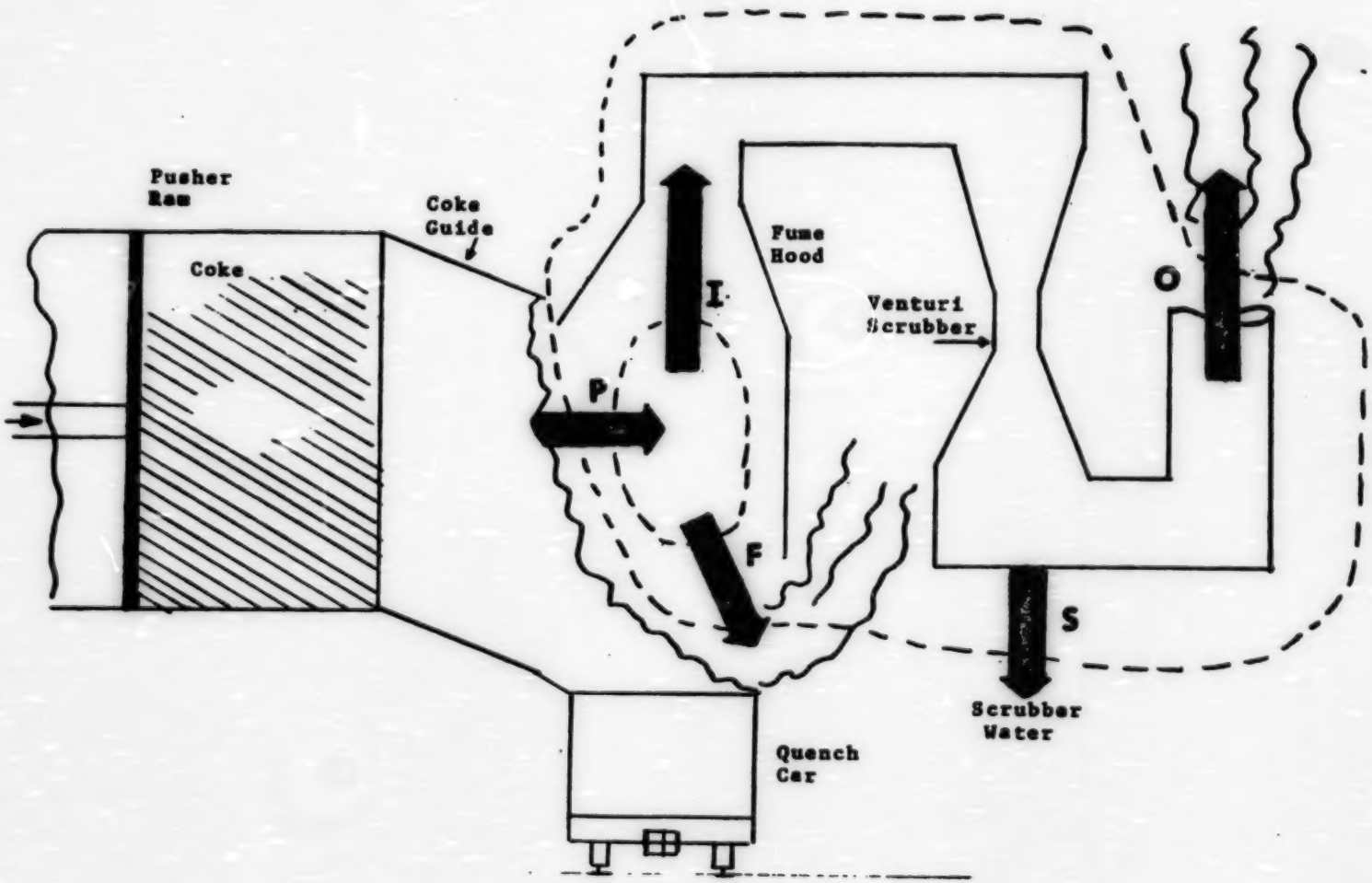


FIGURE 6.2.1

SCHEMATIC DIAGRAM OF MASS BALANCES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

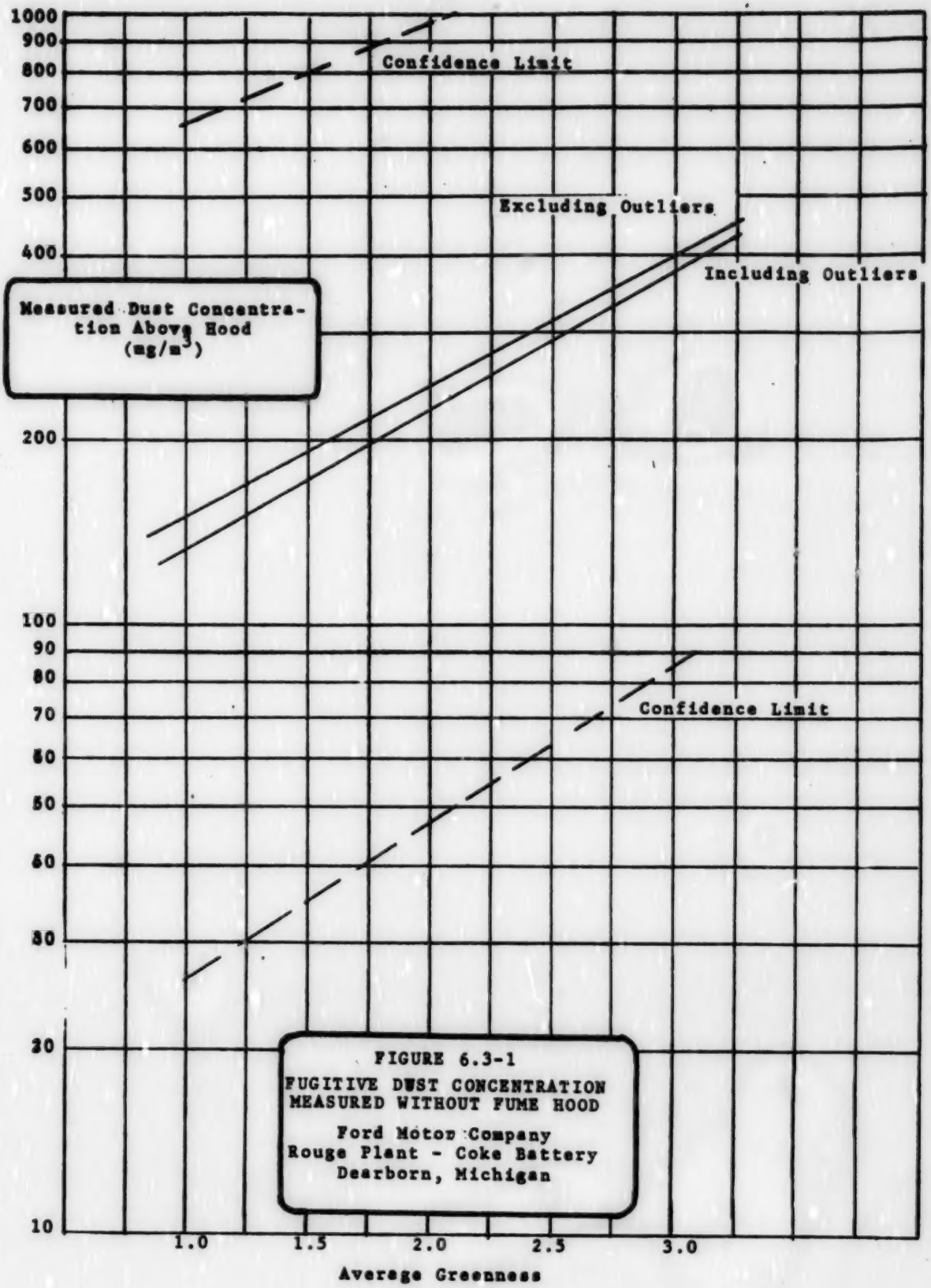


FIGURE 6.3-1
FUGITIVE DUST CONCENTRATION MEASURED WITHOUT FUME HOOD

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

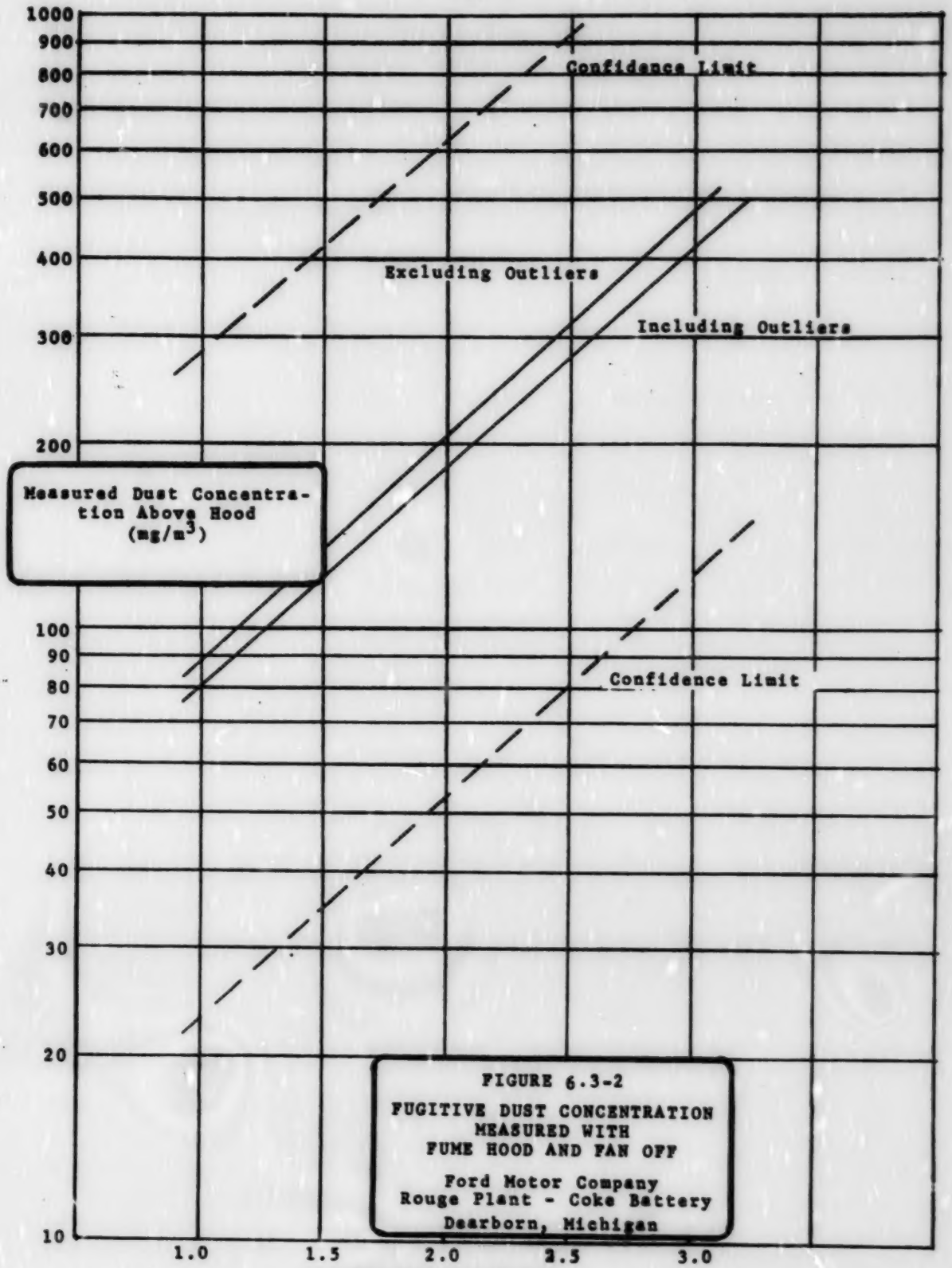


FIGURE 6.3-2

FUGITIVE DUST CONCENTRATION MEASURED WITH FUME HOOD AND FAN OFF

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

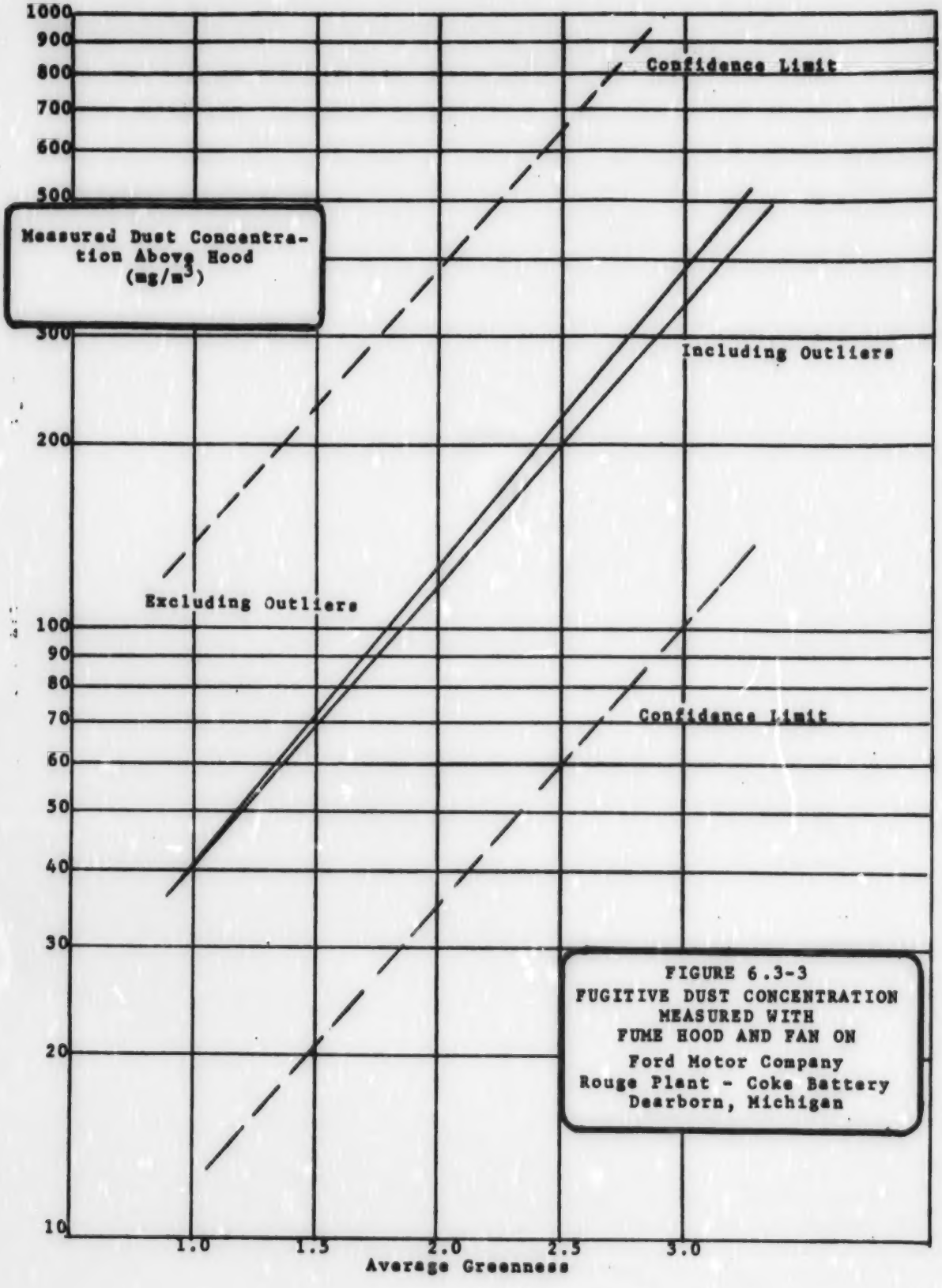


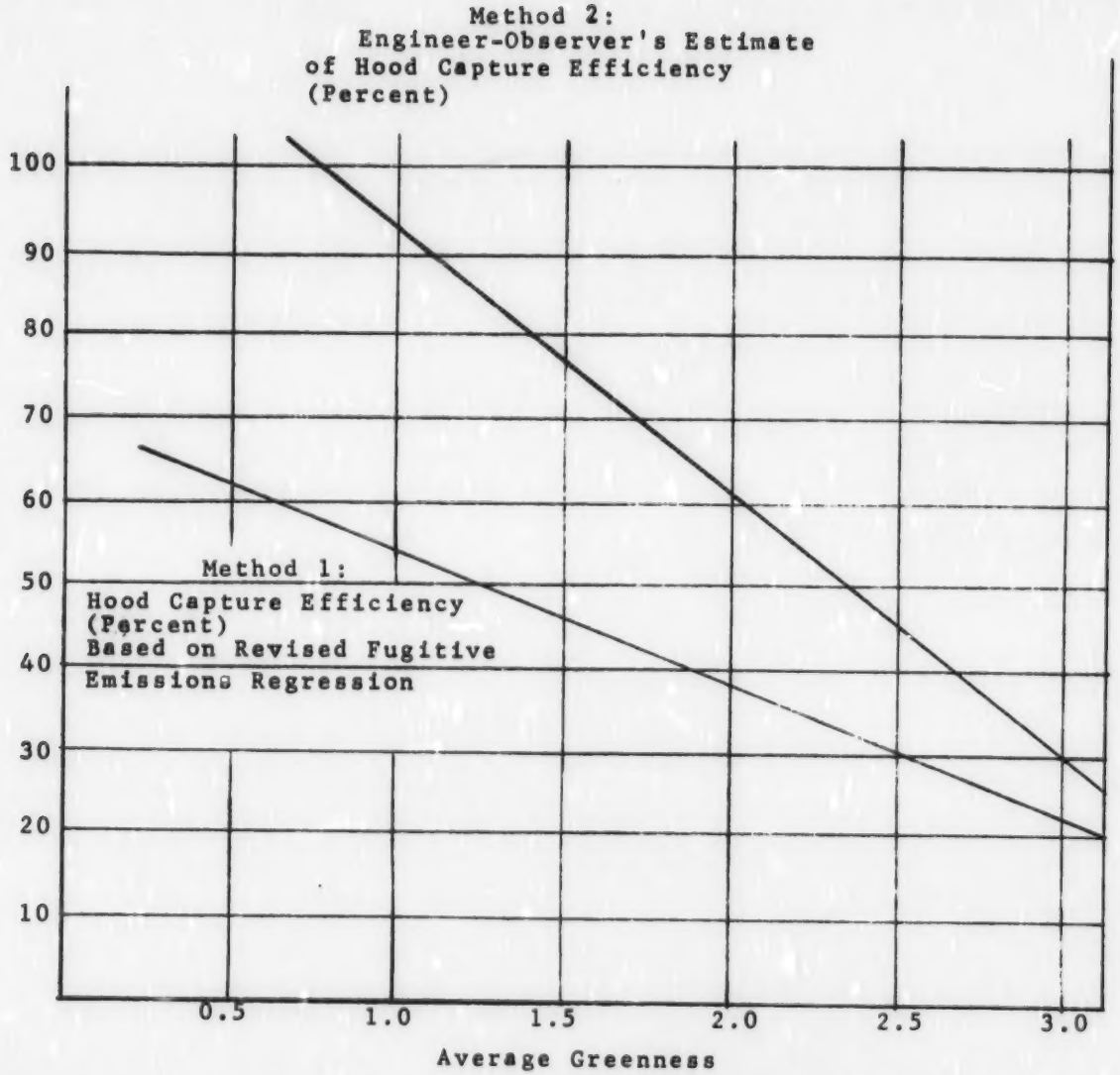
FIGURE 6.3-3
FUGITIVE DUST CONCENTRATION
MEASURED WITH
FUME HOOD AND FAN ON

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

FIGURE 6.3-4

HOOD CAPTURE EFFICIENCY*
AS A FUNCTION OF AVERAGE GREENNESS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



* The data base used in obtaining these correlations relies upon the accuracy of novel and unproven techniques for fugitive emission estimates; as such, the correlations must be used cautiously.

TABLE 7.0-1

SUMMARY OF FILTERABLE PARTICULATE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Filterable Particulate Emissions			Estimated Average Hood Capture Efficiency (%)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/24-25	2.4	1.20	0.0104	99.1	32	49	2.55	1.25	3.75	2.45	32	49
2	6/26-27	2.1	1.04	0.0090	99.1	37	58	1.77	0.753	2.81	1.79	37	57
3	6/30-7/2	2.3	1.24	0.0094	99.2	33	52	2.52	1.14	3.76	2.38	33	52
4	7/2-3	2.0	0.949	0.0073	99.2	38	61	1.55	0.607	2.50	1.56	38	61
5	7/8	1.5	1.26	0.0078	99.4	47	78	1.42	0.355	2.68	1.62	47	78
6	7/10	1.8	1.01	0.0086	99.1	41	67	1.45	0.497	2.46	1.51	41	67
7	7/14	1.7	1.30	0.0074	99.4	43	71	1.72	0.531	3.02	1.83	43	71
8	7/15	1.4	1.13	0.0045	99.6	48	80	1.22	0.282	2.35	1.41	48	80
9	7/16	1.4	0.984	0.0058	99.4	48	80	1.07	0.246	2.05	1.23	48	80
AVERAGE		1.8	1.12	0.0078	99.3	41	66	1.70	0.629	2.82	1.75	41	66

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-2

SUMMARY OF CONDENSIBLE PARTICULATE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date	Average Greenness	Measured Scrubber Condensible Particulate Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ ton of feed)	Outlet (lbs/ ton of feed)	Control Effi- ciency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/24-6/25	2.4	0.0462	0.0326	29.4	32	49	0.0982	0.0481	0.1444	0.0943	9	14
2	6/26-6/27	2.1	0.0184	0.0237	0	37	58	0.0313	0.0133	0.0497	0.0317	0	0
3	6/30-7/2	2.3	0.0430	0.0247	42.6	33	52	0.0873	0.0397	0.1303	0.0827	14	22
4	7/2-7/3	2.0	0.0403	0.0224	44.4	38	61	0.0658	0.0258	0.1061	0.0661	17	27
5	7/8	1.5	0.0293	0.0073	75.1	47	78	0.0330	0.0083	0.0623	0.0376	35	59
6	7/10	1.8	0.0385	0.0099	74.3	41	67	0.0554	0.0190	0.0939	0.0575	30	50
7	7/14	1.7	0.0451	0.0043	90.5	43	71	0.0598	0.0184	0.1049	0.0635	39	64
8	7/15	1.4	0.0150	0.0041	72.7	48	80	0.0162	0.0038	0.0312	0.0188	35	58
9	7/16	1.4	0.0093	0.0097	0	48	80	0.0101	0.0023	0.0194	0.0116	0	0
Average		1.8	0.0317	0.0154	47.7	41	66	0.0508	0.0199	0.0825	0.0515	20	33

* Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.

** Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-3

SUMMARY OF FILTERABLE CHLOROFORM-ETHER SOLUBLE PARTICULATE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company

Rouge Plant - Coke Battery

Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Filterable Chloroform-Ether Soluble Particulate Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/24-25	2.4	0.0113	0.0006	94.7	32	49	0.0240	0.0118	0.0353	0.0231	30	46
2	6/26-27	2.1	0.0186	<0.0003	>98.4	37	58	0.0317	0.0135	0.0503	0.0321	36-37	57-58
3	6/30-7/2	2.3	0.0264	0.0008	97.0	33	52	0.0536	0.0244	0.0800	0.0508	32	50
4	7/2-3	2.0	0.0199	0.0008	96.0	38	61	0.0325	0.0127	0.0524	0.0326	36	59
5	7/8	1.5	0.0231	<0.0005	>97.8	47	78	0.0260	0.0065	0.0491	0.0296	46-47	76-78
6	7/10	1.8	0.0081	<0.0005	>93.8	41	67	0.0117	0.0040	0.0198	0.0121	38-41	63-67
7	7/14	1.7	0.0030	<0.0005	>83.3	43	71	0.0040	0.0012	0.0070	0.0042	36-43	60-71
8	7/15	1.4	0.0021	0.0007	66.7	48	80	0.0023	0.0005	0.0044	0.0026	32	54
9	7/16	1.4	0.0038	0.0018	52.6	48	80	0.0041	0.0010	0.0079	0.0048	25	42
AVERAGE		1.8	0.0129	0.0005-0.0007	86.7-89.7	41	66	0.0211	0.0084	0.0340	0.0213	35-36	56-58

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.

**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-4

SUMMARY OF CONDENSIBLE CHLOROFORM-ETHER SOLUBLE PARTICULATE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date	Average Greenness	Measured Scrubber Condensable Chloroform-Ether Soluble Particulate Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/24-6/25	2.4	0.0047	0.0065	0	32	49	0.0100	0.0049	0.0147	0.0096	0	0
2	6/26-6/27	2.1	<0.0003	0.0010	0	37	58	<0.0005	<0.0002	<0.0008	<0.0005	0	0
3	6/30-7/2	2.3	0.0030	0.0017	43.3	33	52	0.0061	0.0028	0.0091	0.0058	14	22
4	7/2-7/3	2.0	0.0008	0.0026	0	38	61	0.0013	0.0005	0.0021	0.0013	0	0
5	7/8	1.5	0.0025	0.0015	40.0	47	78	0.0028	0.0007	0.0053	0.0032	19	31
6	7/10	1.8	0.0030	<0.0005	>83.3	41	67	0.0043	0.0015	0.0073	0.0045	34-41	56-67
7	7/14	1.7	0.0071	0.0006	91.5	43	71	0.0094	0.0029	0.0165	0.0100	39	65
8	7/15	1.4	0.0044	0.0026	40.9	48	80	0.0048	0.0011	0.0092	0.0055	20	33
9	7/16	1.4	0.0026	0.0035	0	48	80	0.0028	0.0006	0.0054	0.0032	0	0
Average		1.8	0.0031-0.0032	0.0022-0.0023	33-35	41	66	0.0046-0.0047	0.0017	0.0077-0.0078	0.0048	14-15	23-24

* Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
** Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-5
SUMMARY OF SULFUR DIOXIDE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Sulfur Dioxide Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/5	2.0	0.0084	0.0043	49	38	61	0.0137	0.0054	0.0221	0.0138	19	30
2	6/6	1.7	0.0075	0.0035	53	43	71	0.0099	0.0031	0.0174	0.0106	23	38
3	6/6	1.7	0.0072	0.0032	56	43	71	0.0095	0.0029	0.0167	0.0101	24	40
4	6/6	1.7	0.0091	0.0045	51	43	71	0.0121	0.0037	0.0212	0.0128	22	36
5	6/6	1.7	0.0095	0.0035	63	43	71	0.0126	0.0039	0.0221	0.0134	27	45
6	6/9	2.3	0.0117	0.0094	20	33	51	0.0238	0.0112	0.0355	0.0229	6	10
7	6/9	--	0.0091	0.0044	52	--	--	--	--	--	--	-	-
8	6/9	2.0	0.0058	0.0072	0	38	61	0.0095	0.0037	0.0153	0.0095	0	0
9	6/10	3.0	0.0118	0.0074	37	22	30	0.0418	0.0275	0.0536	0.0393	8	11
AVERAGE		2.0	0.0089	0.0053	42	38	61	0.0166	0.0077	0.0255	0.0166	16	26

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-6
SUMMARY OF SULFUR TRIOXIDE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubbar Sulfur Trioxide Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/5	2.0	<0.00043	<0.00059	-	38	61	<0.00070	<0.00027	<0.00113	<0.00070	-	-
2	6/6	1.7	0.00084	<0.00062	>26	43	71	0.0011	<0.00034	0.0019	0.00118	9-42	19-71
3	6/6	1.7	<0.00043	<0.00058	-	43	71	<0.00057	<0.00018	<0.00100	<0.00061	-	-
4	6/6	1.7	<0.00045	<0.0013	-	43	71	<0.00060	<0.00018	<0.00105	<0.00063	-	-
5	6/6	1.7	<0.00043	0.0025	0	43	71	<0.00057	<0.00018	<0.00100	<0.00061	0	0
6	6/9	2.3	<0.0018	<0.0015	-	33	51	<0.0037	<0.0017	<0.0055	<0.0035	-	-
7	6/9	-	<0.00072	<0.00076	-	-	-	--	-	--	--	-	-
8	6/9	2.0	0.0088	<0.00079	>91	38	61	0.014	0.0056	0.023	0.0144	36-39	56-61
9	6/10	3.0	<0.00070	<0.00089	-	22	30	<0.0025	<0.0016	<0.0032	<0.0023	-	-
AVERAGE		2.0	0.0011 - 0.0016	0.0003 - 0.0011	39-67	38	61	0.0019 - 0.0030	0.0007 - 0.0013	0.0031 - 0.0047	0.0019 - 0.0030	15-27	25-44

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-7
SUMMARY OF TOTAL SULFUR OXIDES (AS SULFATE) EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Total Sulfur Oxides (As Sulfate) Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Effiecency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/3	2.3	0.229	0.0588	74.3	33	51	0.465	0.220	0.694	0.449	25	38
2	6/4	1.3	0.0856	0.0170	80.1	49	82	0.0891	0.0188	0.175	0.104	39	66
3	6/4	2.0	0.0353	0.0120	66.0	38	61	0.0576	0.0226	0.0929	0.0579	25	40
4	6/4	1.0	0.0416	0.0207	50.2	54	92	0.0354	0.0036	0.0770	0.0452	27	46
5	6/4	3.0	0.0587	0.0343	41.6	22	30	0.208	0.137	0.267	0.196	9	13
6	6/5	3.0	0.0563	0.0244	56.7	22	30	0.200	0.131	0.256	0.187	12	17
AVERAGE		2.1	0.0844	0.0279	61.5	36	58	0.176	0.089	0.260	0.173	23	37

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-8
SUMMARY OF CARBON MONOXIDE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Carbon Monoxide Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
2	6/4	3	0.021	<0.0034	>84	22	30	0.074	0.049	0.095	0.070	19-22	25-30
5	6/4	1	<0.0032	<0.0035	-	54	92	<0.0027	<0.00028	<0.0059	<0.0035	-	-
8	6/4	-	<0.0033	<0.0036	-	-	-	--	--	--	--	-	-
11	6/12	1	<0.0033	<0.0036	-	54	92	<0.0028	<0.00029	<0.0061	<0.0036	-	-
13	7/16	2	0.034	<0.022	>35	38	61	0.055	0.022	0.089	0.056	13-38	21-61
16	7/16	1	0.038	<0.022	>42	54	92	0.032	0.0033	0.070	0.041	23-54	38-92
AVERAGE		1.6	0.016-0.017	<0.010	>54	44	73	0.032-0.033	0.015	0.051-0.053	0.033-0.035	18-38	28-61

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-9
SUMMARY OF NITROGEN OXIDES (as NO_2) EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Nitrogen Oxides Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/10	1	0.0064	0.0118	0	54	92	0.0055	0.00056	0.0119	0.0070	0	0
2	6/10	3	0.0170	0.0205	0	22	30	0.0603	0.0397	0.0773	0.0567	0	0
3	6/10	1	0.0050	0.0051	0	54	92	0.0043	0.00043	0.0093	0.0054	0	0
4	6/10	1	0.0033	0.0051	0	54	92	0.0028	0.00029	0.0061	0.0036	0	0
5	6/10	3	0.0080	0.0395	0	22	30	0.028	0.019	0.036	0.027	0	0
6	6/11	1	0.0018	0.0050	0	54	92	0.0015	0.00016	0.0033	0.0020	0	0
7	6/11	2	0.0139	0.0281	0	38	61	0.0227	0.00889	0.0366	0.0228	0	0
8	6/11	1	<0.0017	0.0016	0	54	92	<0.0014	<0.00015	<0.0031	<0.0018	0	0
9	6/11	1	0.0017	0.0017	0	54	92	0.0014	0.00015	0.0031	0.0018	0	0
10	7/18	1	<0.0017	<0.0018	–	54	92	<0.0014	<0.00015	<0.0031	<0.0018	–	–
11	7/18	1	0.0017	0.0019	0	54	92	0.0014	0.00015	0.0031	0.0018	0	0
12	7/18	2	0.0017	0.0035	0	38	61	0.0028	0.0011	0.0045	0.0028	0	0
13	7/18	3	0.0017	0.0124	0	22	30	0.0060	0.0040	0.0077	0.0057	0	0
AVERAGE		1.6	0.0048-0.0050	0.0105-0.0106	0	44	73	0.011	0.0057	0.015-0.016	0.011	0	0

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-10
SUMMARY OF BENZENE EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Benzene Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/5	3	0.0007	<0.0003	>57	22	30	0.002	0.002	0.003	0.003	23-33	23-35
3	6/5	3	0.002	<0.0003	>85	22	30	0.007	0.005	0.009	0.007	19-22	24-29
5	6/5	2	<0.0002	<0.0003	-	38	61	<0.0003	<0.0001	<0.0005	<0.0003	-	-
7	6/5	2	<0.0002	<0.0003	-	38	61	<0.0003	<0.0001	<0.0005	<0.0003	-	-
9	6/6	1.7	<0.00008	<0.0001	-	43	71	<0.0001	<0.00003	<0.0002	<0.00011	-	-
11	6/6	2.3	<0.00008	<0.0001	-	33	51	<0.0002	<0.00008	<0.0003	<0.00016	-	-
AVERAGE		2.3	0.0004-0.0005	<0.0002	>71	33	51	0.002	0.001	0.002	0.002	21-28	24-31

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-11
SUMMARY OF BENZENE & HOMOLOGUES EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Benzene & Homologues Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/5	3	0.0012	0.0076	0	22	30	0.0043	0.0028	0.0055	0.0040	0	0
3	6/5	3	0.0372	0.0105	72	22	30	0.132	0.0868	0.169	0.1240	16	22
5	6/5	2	0.0024	0.0016	33	38	61	0.0039	0.0015	0.0063	0.0039	13	21
7	6/5	2	0.00070	0.0022	0	38	61	0.0011	0.00045	0.0018	0.00115	0	0
9	6/6	1.7	0.00079	0.00073	8	43	71	0.0010	0.00032	0.0018	0.00111	4	5
11	6/6	2.3	0.0050	0.00031	94	33	51	0.010	0.0048	0.015	0.0098	31	48
AVERAGE		2.3	0.0079	0.0038	34	33	51	0.025	0.016	0.033	0.024	11	16

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-12
SUMMARY OF TOTAL LIGHT HYDROCARBONS (AS METHANE) EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Total Light Hydrocarbons Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/4	2	0.0073	0.012	0	38	61	0.012	0.0047	0.019	0.0120	0	0
4	6/4	1	0.0056	0.0034	39	54	92	0.0048	0.00049	0.0104	0.0061	21	36
7	6/4	3	0.0008	0.0053	0	22	30	0.003	0.002	0.004	0.003	0	0
10	6/12	1	0.0006	0.0006	0	54	92	0.0005	0.00005	0.0011	0.0006	0	0
14	7/16	1	0.001	0.0027	0	54	92	0.0009	0.00009	0.002	0.001	0	0
17	7/16	1	0.0968	0.0022	98	54	92	0.0825	0.00842	0.1793	0.1052	53	90
AVERAGE		1.5	0.019	0.0044	23	46	76	0.017	0.0026	0.036	0.021	12	21

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE J.0-13
SUMMARY OF METHANE & HOMOLOGUES EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Methane & Homologues Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/4	2	0.001	0.003	0	38	61	0.002	0.0006	0.003	0.002	0	0
4	6/4	1	0.003	0.001	67	54	92	0.003	0.0003	0.006	0.003	33	57
7	6/4	3	0.0004	0.0006	0	22	30	0.001	0.0009	0.001	0.0013	0	0
10	6/12	1	0.0004	0.0006	0	54	92	0.0003	0.00003	0.0007	0.0004	0	0
14	7/16	1	0.0006	0.0004	33	54	92	0.0005	0.00005	0.0011	0.0006	18	25
17	7/16	1	0.0004	0.0006	0	54	92	0.0003	0.00003	0.0007	0.0004	0	0
AVERAGE		1.5	0.001	0.001	17	46	76	0.001	0.0003	0.002	0.001	8	14

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.0-14
SUMMARY OF ETHYLENE & HOMOLOGUES EMISSIONS AND CONTROL EFFICIENCIES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Date (1975)	Average Greenness	Measured Scrubber Ethylene & Homologues Emissions			Estimated Average Hood Capture Efficiency (Percent)		Estimated Fugitive Emissions (lbs/ton of feed)		Estimated Push Emissions (lbs/ton of feed)		Estimated Total System Efficiency (Percent)	
			Inlet (lbs/ton of feed)	Outlet (lbs/ton of feed)	Control Efficiency (%)	Method 1*	Method 2**	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2	Based on Method 1	Based on Method 2
1	6/4	2	0.001	0.006	0	38	61	0.002	0.0006	0.003	0.002	0	0
4	6/4	1	0.005	0.0003	94	54	92	0.004	0.0004	0.009	0.005	52	86
7	6/4	3	0.0004	0.0007	0	22	30	0.001	0.0009	0.001	0.0013	0	0
10	6/12	1	<0.0002	<0.0002	-	54	92	<0.0002	<0.00002	<0.0004	<0.0002	-	-
14	7/16	1	<0.0002	0.0007	0	54	92	<0.0002	<0.00002	<0.0004	<0.0002	0	0
17	7/16	1	0.0606	0.0002	99.7	54	92	0.0516	0.00527	0.1122	0.0659	54	92
AVERAGE		1.5	0.011	0.001	39	46	76	0.010	0.001	0.021	0.012	21	36

*Method 1: Hood capture efficiency estimated from linear regression on fugitive emissions concentrations.
**Method 2: Hood capture efficiency estimated from linear regression on engineering observer's estimate of hood capture efficiency.

TABLE 7.3.1-1

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 1 (A, B, and C)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.3	421.2	92.7	100.0
7.3 - 4.9	5.5	1.2	7.3
4.9 - 3.5	7.6	1.7	6.1
3.5 - 2.1	6.0	1.3	4.4
2.1 - 1.1	7.2	1.6	3.1
1.1 - 0.67	3.7	0.8	1.5
0.67- 0.46	1.7	0.4	0.7
<0.46	1.4	0.3	0.3

TABLE 7.3.1-2

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 2 (A, B, and C)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.2	359.9	90.7	100.0
7.2 - 4.7	6.9	1.7	9.3
4.7 - 3.3	6.5	1.6	7.6
3.3 - 2.1	7.2	1.8	6.0
2.1 - 1.1	8.6	2.2	4.2
1.1 - 0.65	4.7	1.2	2.0
0.65- 0.44	2.0	0.5	0.8
<0.44	1.0	0.3	0.3

TABLE 7.3.1-3

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 3 (A, B, and C)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.2	517.2	89.2	100.0
7.2 - 4.8	7.9	1.4	10.8
4.8 - 3.3	16.2	2.8	9.4
3.3 - 2.1	5.2	0.9	6.6
2.1 - 1.1	9.2	1.6	5.7
1.1 - 0.66	4.4	0.7	4.1
0.66- 0.45	18.3	3.2	3.4
<0.45	1.2	0.2	0.2

TABLE 7.3.1-4

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 4 (A, B, and C)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.4	301.5	86.0	100.0
7.4 - 4.9	6.8	2.0	14.0
4.9 - 3.4	6.6	1.9	12.0
3.4 - 2.1	9.0	2.6	10.1
2.1 - 1.1	11.7	3.3	7.5
1.1 - 0.67	8.1	2.3	4.2
0.67- 0.46	4.6	1.3	1.9
<0.46	2.2	0.6	0.6

TABLE 7.3.1-5

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 5 (A)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.1	76.1	90.3	100.0
7.1 - 4.7	1.7	2.0	9.7
4.7 - 3.3	1.3	1.5	7.7
3.3 - 2.1	1.6	1.9	6.2
2.1 - 1.1	1.6	1.9	4.3
1.1 - 0.65	1.0	1.2	2.4
0.65- 0.44	0.5	0.6	1.2
<0.44	<0.5	<0.6	0.6

TABLE 7.3.1-6

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 6 (A, B, and C)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.1	250.3	87.6	100.0
7.1 - 4.8	6.8	2.4	12.4
4.8 - 3.3	6.0	2.1	10.0
3.3 - 2.1	8.3	2.9	7.9
2.1 - 1.1	7.4	2.6	5.0
1.1 - 0.65	4.7	1.6	2.4
0.65- 0.45	1.5	0.5	0.8
<0.45	0.8	0.3	0.3

TABLE 7.3.1-7

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Inlet 7 (A, B, and C)

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.2	283.9	91.7	100.0
7.2 - 4.8	6.8	2.2	8.3
4.8 - 3.4	3.7	1.2	6.1
3.4 - 2.1	6.1	2.0	4.9
2.1 - 1.1	5.5	1.8	2.9
1.1 - 0.66	2.3	0.7	1.1
0.66- 0.45	0.7	0.2	0.4
<0.45	<0.5	<0.2	0.2

TABLE 7.3.1-8

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 1

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>9.0	3.9	33.3	100.0
9.0 - 6.0	0.8	6.8	66.7
6.0 - 4.1	0.7	6.0	59.9
4.1 - 2.6	0.4	3.4	53.9
2.6 - 1.4	3.6	30.8	50.5
1.4 - 0.81	0.8	6.9	19.7
0.81- 0.57	1.1	9.4	12.8
<0.57	0.4	3.4	3.4

TABLE 7.3.1-9

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 2

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>7.1	1.3	25.0	100.0
7.1 - 4.7	<0.5	<9.6	75.0
4.7 - 3.4	<0.5	<9.6	65.4
3.4 - 2.1	<0.5	<9.6	55.8
2.1 - 1.1	<0.5	<9.6	46.2
1.1 - 0.65	<0.5	<9.6	36.6
0.65- 0.44	<0.5	<9.6	27.0
<0.44	0.9	17.4	17.4

TABLE 7.3.1-10

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 3

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>6.4	2.0	26.3	100.0
6.4 - 4.2	0.6	7.9	73.7
4.2 - 2.9	0.6	7.9	65.8
2.9 - 1.9	<0.5	<6.6	57.9
1.9 - 0.94	0.8	10.5	51.3
0.94- 0.58	1.5	19.7	40.8
0.58- 0.39	1.0	13.2	21.1
<0.39	0.6	7.9	7.9

TABLE 7.3.1-11

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 4

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>6.4	<0.5	<11.4	100.0
6.4 - 4.2	<0.5	<11.4	88.6
4.2 - 2.9	<0.5	<11.4	77.2
2.9 - 1.8	<0.5	<11.4	65.8
1.8 - 0.92	<0.5	<11.3	54.4
0.92- 0.56	<0.5	<11.3	43.1
0.56- 0.38	0.5	11.3	31.8
<0.38	0.9	20.5	20.5

TABLE 7.3.1-12

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 5

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>6.2	<0.5	—	—
6.2 - 4.1	<0.5	—	—
4.1 - 2.9	<0.5	—	—
2.9 - 1.8	<0.5	—	—
1.8 - 0.91	<0.5	—	—
0.91- 0.56	<0.5	—	—
0.56- 0.38	<0.5	—	—
<0.38	<0.5	—	—

TABLE 7.3.1-13

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 6

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>6.1	<0.5	< 7.9	100.0
6.1 - 4.1	<0.5	< 7.9	92.1
4.1 - 2.9	<0.5	< 7.9	84.2
2.9 - 1.8	0.6	9.6	76.3
1.8 - 0.91	<0.5	< 7.9	66.7
0.91 - 0.55	0.6	9.6	58.8
0.55 - 0.38	<0.5	< 7.9	49.2
<0.38	2.6	41.3	41.3

TABLE 7.3.1-14

PARTICLE SIZE DISTRIBUTION

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test Number: Outlet 7

Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
		Percent	Cumulative Percent
>6.3	0.9	20.5	100.0
6.3 - 4.2	<0.5	<11.4	79.5
4.2 - 3.0	<0.5	<11.4	68.1
3.0 - 1.9	<0.5	<11.4	56.7
1.9 - 0.93	<0.5	<11.4	45.3
0.93- 0.57	<0.5	<11.3	33.9
0.57- 0.39	<0.5	<11.3	22.6
<0.39	<0.5	<11.3	11.3

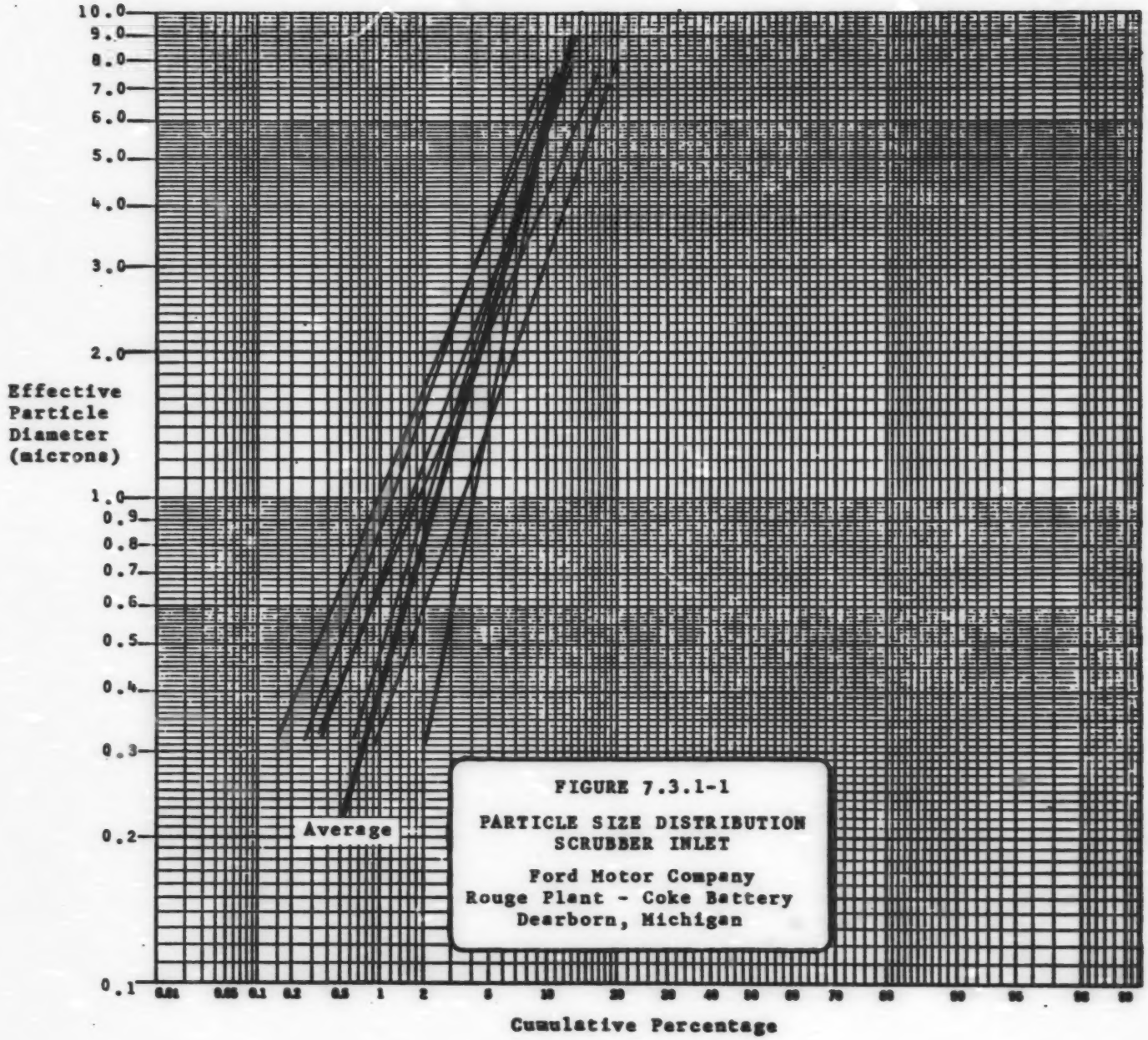


FIGURE 7.3.1-1

PARTICLE SIZE DISTRIBUTION
SCRUBBER INLET

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

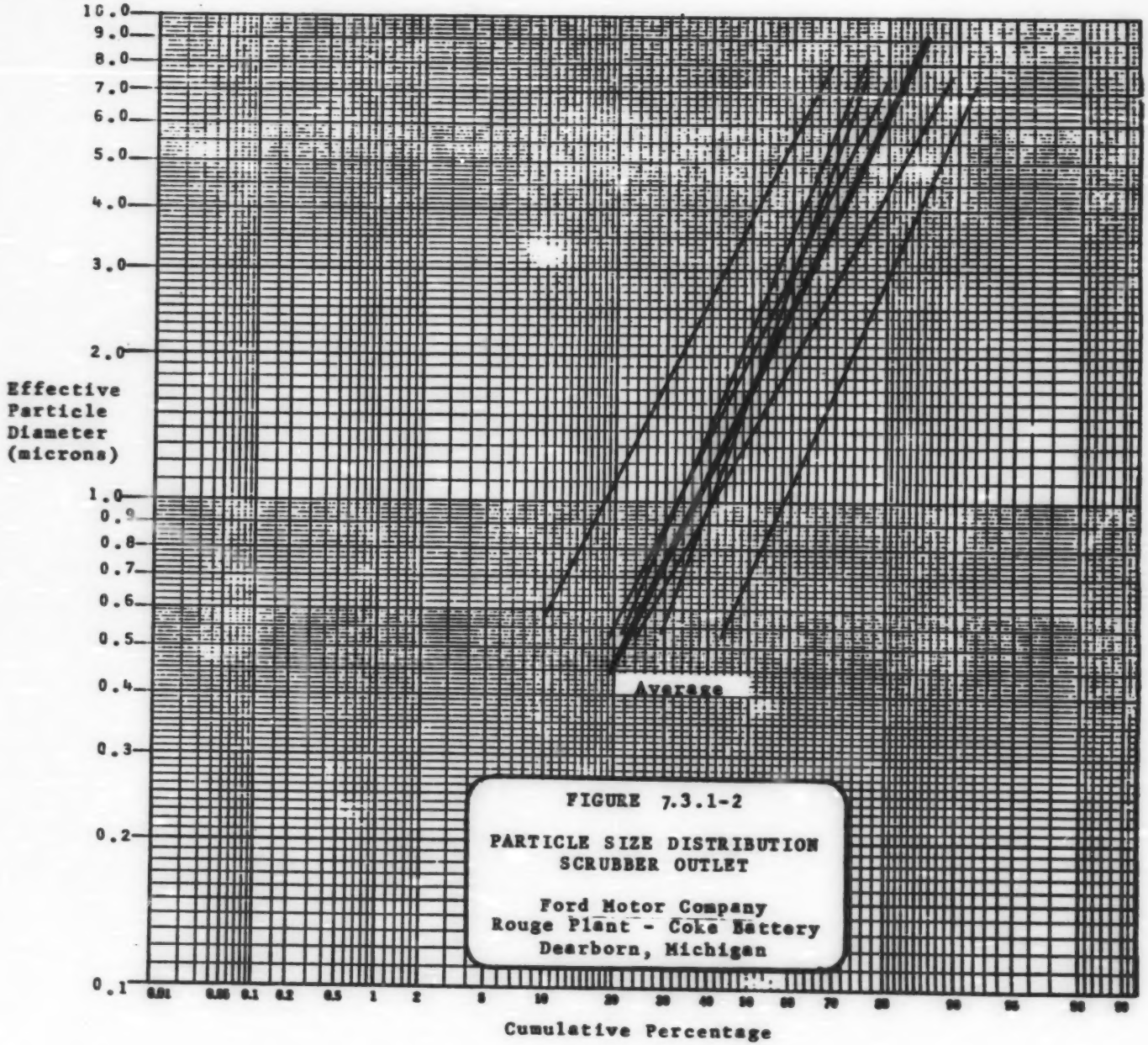


FIGURE 7.3.1-2

PARTICLE SIZE DISTRIBUTION
SCRUBBER OUTLET

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

TABLE 7.3.1-15

CONCENTRATION OF PARTICULATE MATTER
CALCULATED FROM PARTICLE SIZING SAMPLES

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Sampling Station	Test No.	1975 Date	Sampling Period		Sampled Volume (DSCF)	Sample Weight (mg)	Concentration (gr/DSCF)
			Start	Stop			
Coke Battery A Scrubber Inlet	1A	9/4	09:00	09:52			
	1B	9/4	14:25	15:14	6.00	454.3	1.17
	1C	9/5	09:04	09:31			
	2A	9/5	12:51	13:32			
	2B	9/8	10:36	11:52	6.78	396.8	0.903
	2C	9/8	13:37	14;32			
	3A	9/9	09:59	10:00			
		9/10	08:22	08:36			
	3B	9/10	10:05	10:35	6.65	579.6	1.34
	3C	9/10	11:55	12:26			
	4A	9/10	14:06	14:28			
	4B	9/11	08:41	09:10	6.77	350.5	0.799
	4C	9/11	10:41	11:19			
	5A	9/11	14:06	14:26	2.36	84.3	0.551
	6A	9/12	08:28	10:10			
	6B	9/12	12:25	12:39			
		9/15	08:25	08:26	7.00	285.8	0.630
	6C	9/15	09:55	10:11			
	7A	9/15	12:23	13:23			
	7B	9/15	14:25	14:57	7.04	309.5	0.678
	7C	9/16	08:34	08:56			
Coke Battery A Scrubber Outlet	1	9/4	09:00	15:14	4.26	11.7	0.042
		9/5	09:04	09:31			
	2	9/5	12:51	13:32	7.12	2.2	0.005
		9/6	10:36	14:32			
	3	9/9	09:59	10:00	9.34	7.1	0.012
		9/10	08:22	12:26			
	4	9/10	14:06	14:28	9.51	1.4	0.002
		9/11	08:41	11:19			
	5	9/11	14:06	14:26	3.28	<0.5	<0.002
	6	9/12	09:56	12:39	9.62	3.8	0.006
		9/15	08:25	10:11			
	7	9/15	12:23	14:57	9.11	0.9	0.002
		9/16	08:34	08:56			

TABLE 7.3.1-16

COMPOSITION OF PARTICULATE MATTER, PERCENT
SCRUBBER INLET

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Sulfate		Iron		Aluminum		Titanium		Chloride	
	Filterable	Total	Filterable	Total	Filterable	Total	Filterable	Total	Filterable	Total
1	0.3	1.5	1.4	1.4	0.7	0.7	<0.05	<0.08	0.2	0.2
2	0.4	1.2	1.1	1.1	0.9	0.9	<0.06	<0.1	0.2	0.2
3	0.4	1.8	1.6	1.5	0.6	0.6	<0.05	<0.08	0.2	0.2
4	0.4	3.4	0.9	0.8	0.6	0.5	<0.1	<0.1	0.3	0.3
5	0.3	1.3	0.6	0.6	0.5	0.5	—	—	0.2	0.2
6	0.5	1.8	0.4	0.4	0.6	0.6	—	—	0.2	0.2
7	0.5	1.6	0.5	0.5	0.3	0.2	—	—	0.09	0.09
8	0.5	1.0	0.4	0.4	0.2	0.2	—	—	0.1	0.1
9	0.6	0.9	0.5	0.5	0.3	0.3	—	—	0.06	0.06

TABLE 7.3.1-17

COMPOSITION OF PARTICULATE MATTER, PERCENT
SCRUBBER OUTLET

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Test No.	Sulfate		Iron		Aluminum		Titanium		Chloride	
	Filterable	Total	Filterable	Total	Filterable	Total	Filterable	Total	Filterable	Total
1	<38.4	16.2	2.2	0.5	2.9	0.7	<3.6	<1.8	9.8	2.4
2	66.2	27.0	0.5	0.1	<0.7	<0.4	<4.2	<2.3	24.2	6.7
3	33.8	30.0	1.2	0.3	1.4	0.4	<4.0	<2.0	31.6	9.6
4	50.6	30.6	2.9	0.7	<1.3	<0.6	<7.6	<3.8	10.6	2.6
5	<29.8	19.8	0.9	0.6	6.9	3.6	—	—	3.7	1.9
6	<28.7	26.7	<0.05	0.1	1.5	0.7	—	—	4.9	2.3
7	46.0	44.2	1.1	1.0	11.3	7.2	—	—	2.0	4.9
8	61.7	55.6	1.6	1.5	6.4	3.3	—	—	5.5	2.9
9	45.9	31.9	0.9	0.4	3.0	1.1	—	—	6.2	2.3

TABLE 7.3.9-1

SUMMARY OF TOTAL UNCONTROLLED EMISSIONS

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

Contaminant	Total Uncontrolled Emissions (lbs/ton of feed)	
	Range*	Average**
Filterable Particulate	1.23 - 3.76	2.28
Condensibles	0.0116 - 0.144	0.067
Sulfur Dioxide	0.006 - 0.081	0.018
Sulfur Trioxide	<0.0008 - 0.014	0.002-0.003
Total Sulfur Oxides (as Sulfate)	0.024 - 0.52	0.16
Carbon Monoxide	<0.004 - 0.074	0.024-0.026
Nitrogen Oxides (as NO_2)	<0.002 - 0.081	0.019
Benzene	<0.0001 - 0.007	0.001-0.002
Benzene and Homologues	0.001 - 0.14	0.025
Total Light Hydrocarbons (as Methane)	0.006 - 0.085	0.014
Methane and Homologues	0.0004 - 0.005	0.002
Ethylene and Homologues	<0.0002 - 0.052	0.007

* The range is defined by the lowest and highest values in each respective Table 7.0-1 to 7.0-14 without regard for the method of hood capture efficiency estimation.

** The average is the arithmetic average of all values in each respective Table 7.0-1 to 7.0-14 without regard for the method of hood capture efficiency estimation.

TABLE 7.3.9-2

SUMMARY OF MEASURED EMISSIONS FOR CONTAMINANTS PRESENT
BELOW LIMITS OF DETECTABILITY

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

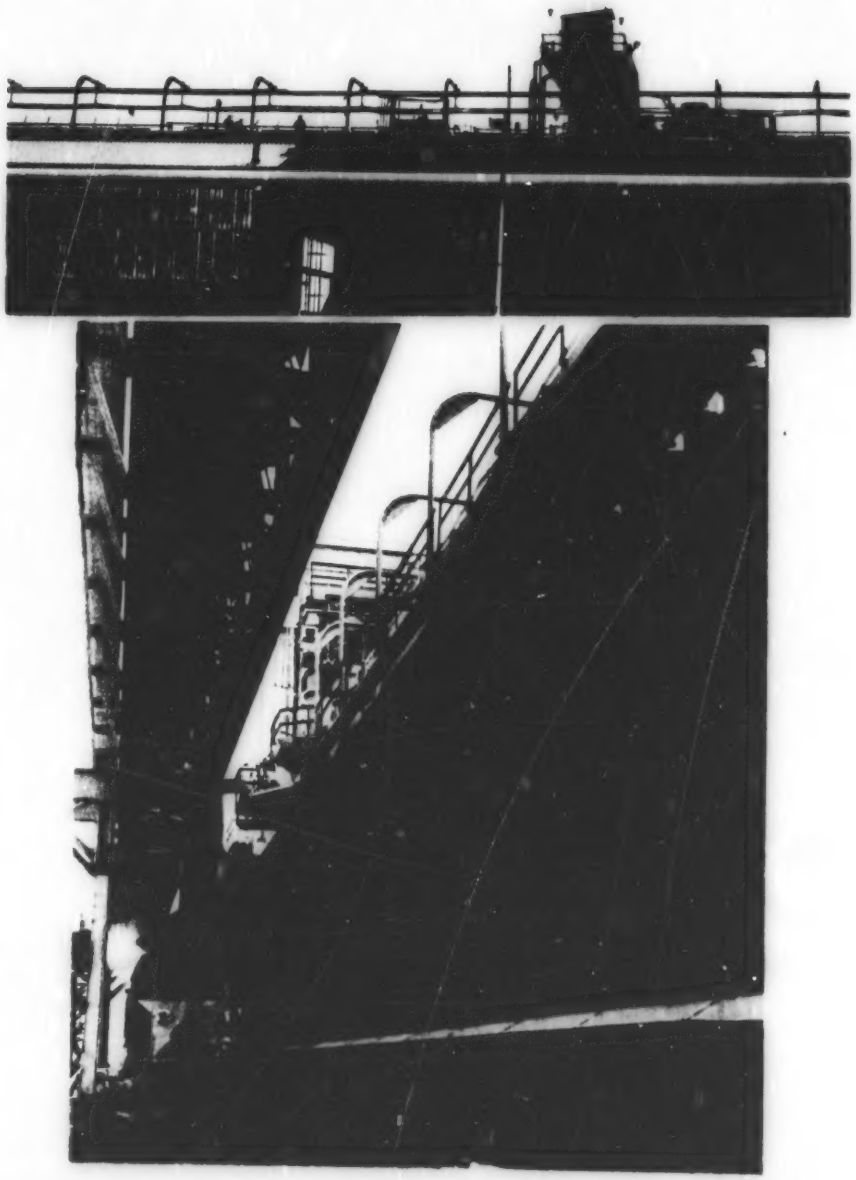
Contaminant	Scrubber Inlet (lbs/ton of feed)		Scrubber Outlet (lbs/ton of feed)	
	Range	Average	Range	Average
Acetylene	<0.00015-<0.00017	<0.00016	<0.00016 -<0.00019	<0.00018
Acridine	<0.00008-<0.00009	<0.00008	<0.00007 -<0.00009	<0.00008
Filterable Acrolein	—	—	<0.000086-<0.000096	<0.000091
Total Acrolein	—	—	<0.00037 -<0.00035	<0.00036
Ammonia	—	—	<0.005 -<0.004	<0.004
Anthracene	<0.00008-<0.00009	<0.00008	<0.00007 -<0.00009	<0.00008
Benzo(a+e)pyrene	<0.00004-<0.00005	<0.00004	<0.00004	<0.00004
Carbazole	<0.00008-<0.00009	<0.00008	<0.00007 -<0.00009	<0.00008
Carbon Disulfide	<0.004 -<0.011	<0.008	<0.005 -<0.015	<0.010
Chlorine	—	—	<0.000009	<0.000009
Chrysene	<0.00004-<0.00005	<0.00004	<0.00004	<0.00004
Filterable Cyanide	—	—	0.00010 - 0.00019	0.00014
Total Cyanide	(<0.02 - 0.43)*	(0.14-0.16)*	0.00065 - 0.00069	0.00067
Fluoranthene	<0.00004-<0.00005	<0.00004	<0.00004	<0.00004
Fluorene	<0.00004-<0.00005	<0.00004	<0.00004	<0.00004
9-Fluorenone	<0.00004-<0.00005	<0.00004	<0.00004	<0.00004
Hydrogen Sulfide	(<0.42 -<0.43)*	(<0.42)*	<0.001	<0.001
Filterable Naphthalene	<0.00009 <0.00010	<0.00010	—	—
Total Naphthalene	<0.00004-<0.00005	<0.00004	<0.00004- 0.0029	0.00058-0.00068
Phenanthrene	<0.00008-<0.00009	<0.00008	<0.00007-<0.00009	<0.00008
Filterable Phenolics	<0.00055-<0.0011	<0.00069	<0.00042-<0.00047	<0.00044
Total Phenolics	<0.00098-<0.0016	<0.0011	<0.00080-<0.00086	<0.00082
Pyrene	<0.00004-<0.00005	<0.00004	<0.00004	<0.00004
Pyridine	<0.00008 <0.0002	<0.0002	<0.0001 -<0.0003	<0.0002

* Concentration in ppm due to lack of coal charge data.

FIGURE 8.2.1-1

A CLEAN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



30-29

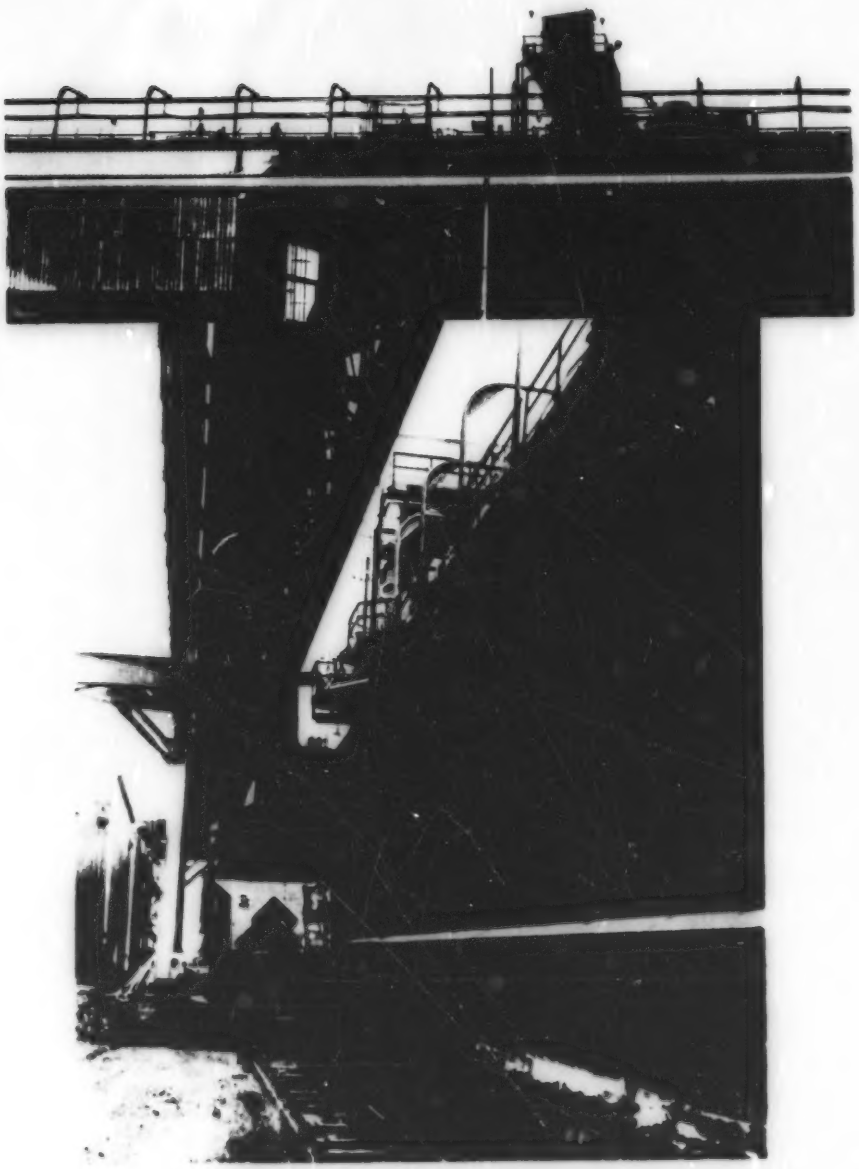
31-28

FIGURE 8.2.1-1 (continued)

A CLEAN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan

30-30



31-29

FIGURE 8.2.1-1 (continued)

A CLEAN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



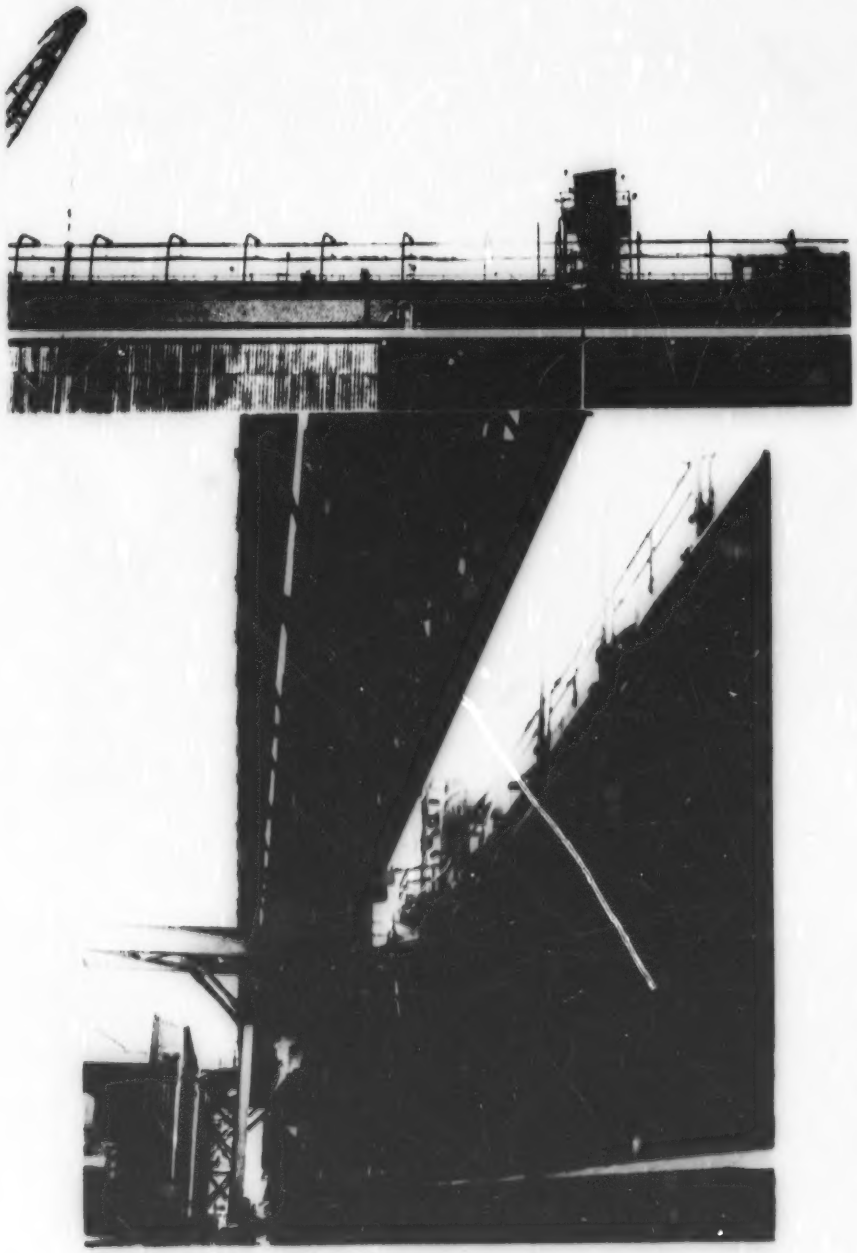
30-31

31-30

FIGURE 8.2.1-2

A MODERATELY GREEN PUSH WITH CONTROL SYSTEM [illegible] ING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



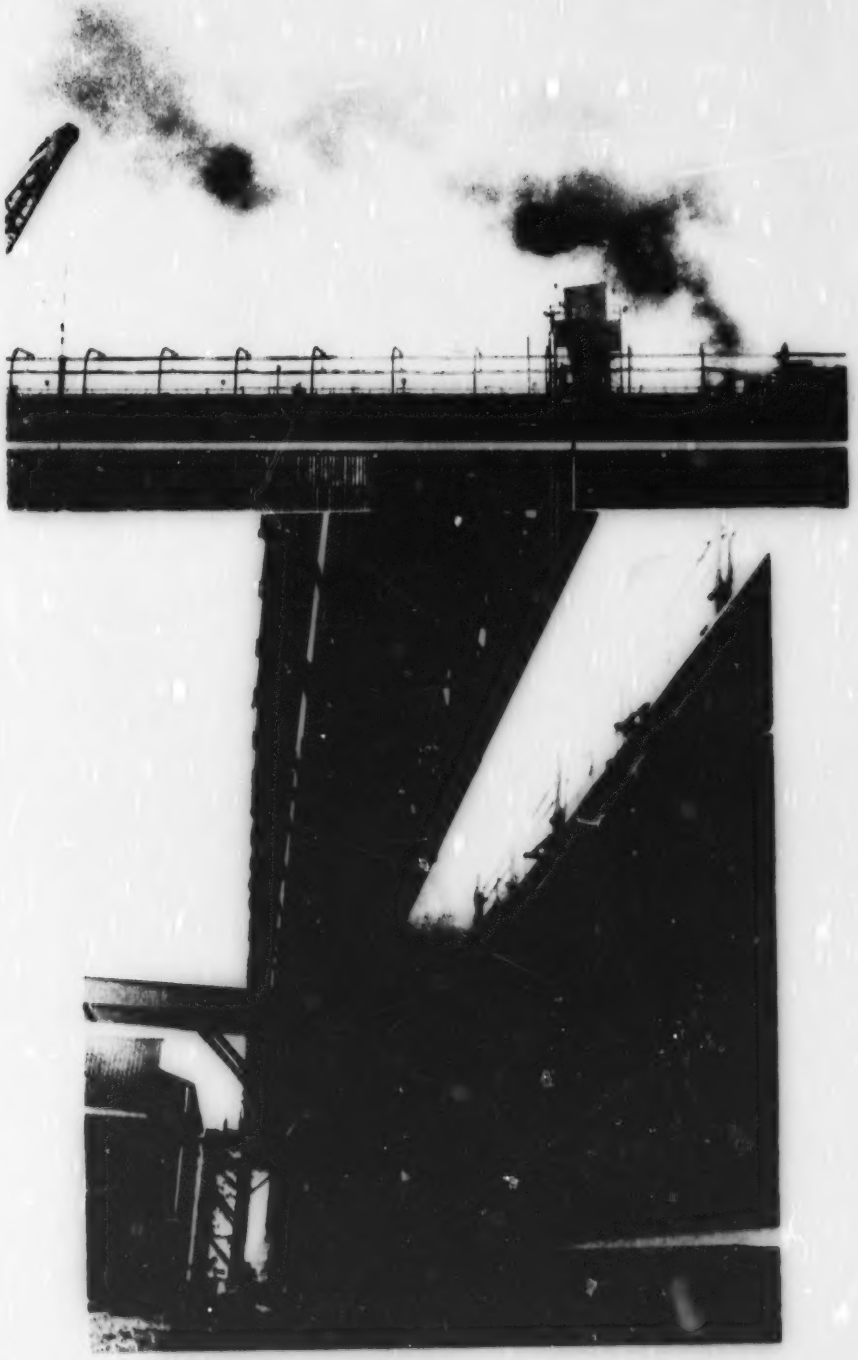
34-16

35-15

FIGURE 8.2.1-2 (continued)

A MODERATELY GREEN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



34-17

35-16

FIGURE 8.2.1-2 (continued)

A MODERATELY GREEN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



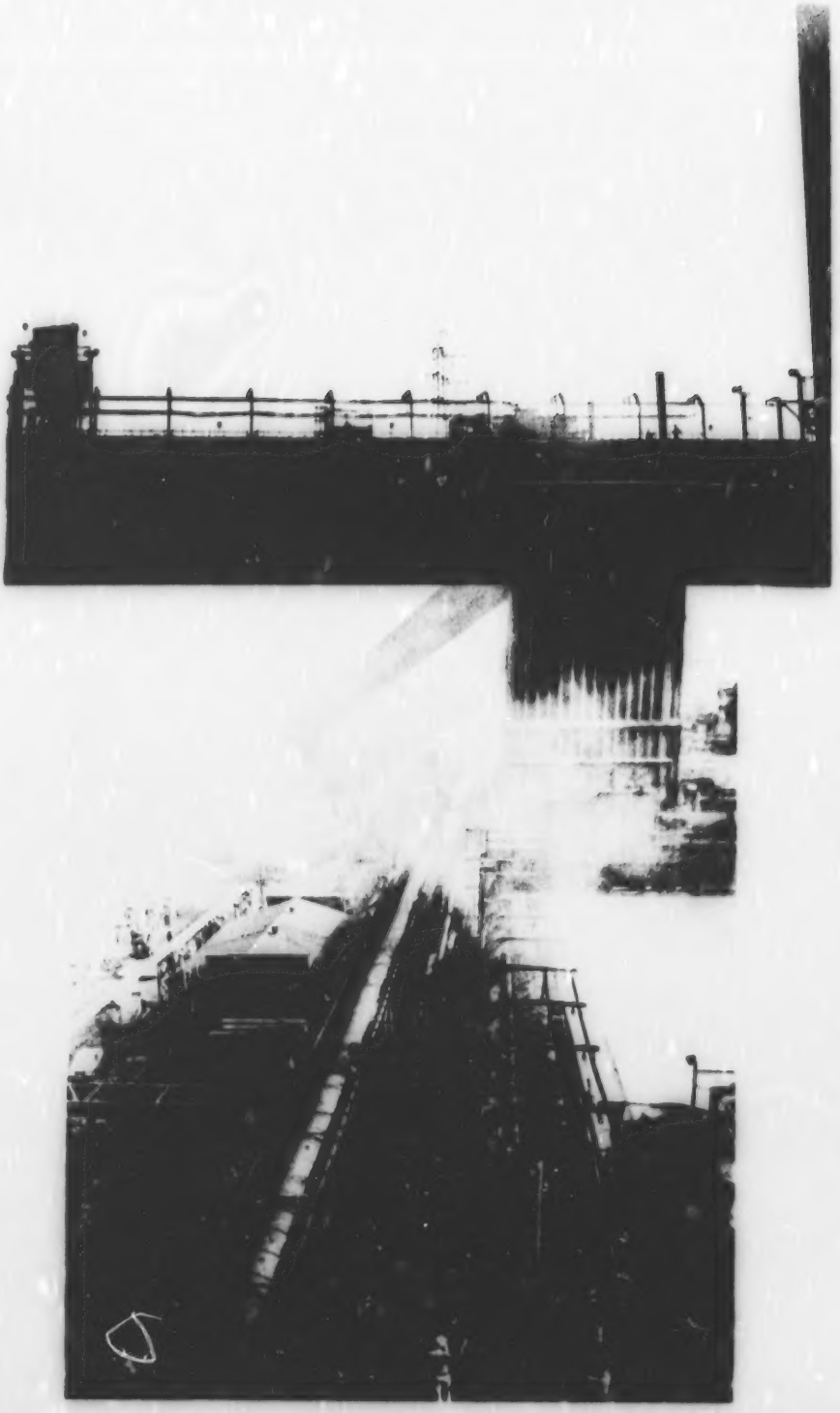
34-18

35-17

FIGURE 8.2.1-3

A GREEN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant.- Coke Battery
Dearborn, Michigan



36-4

37-4

FIGURE 8.2.1-3 (continued)

A GREEN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



36-5

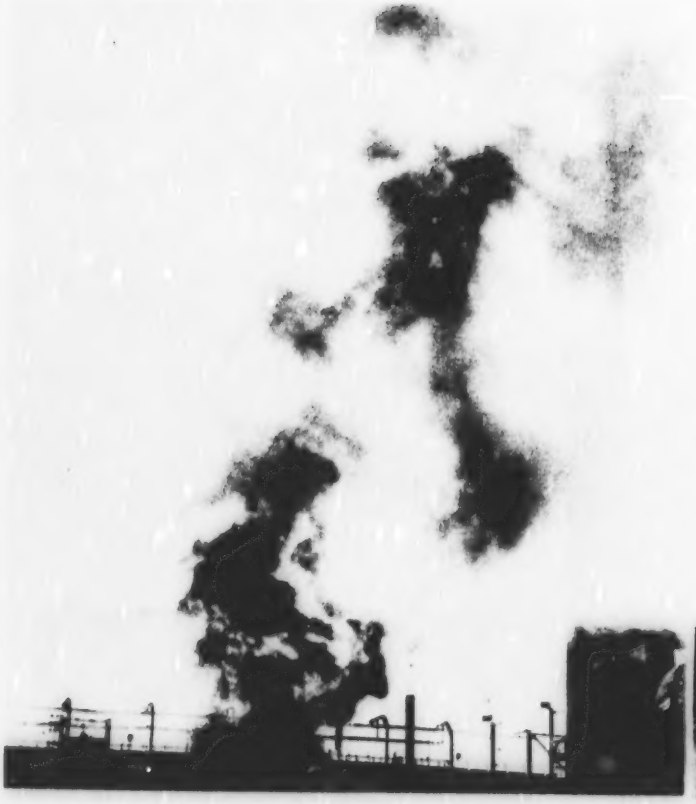


37-5

FIGURE 8.2.1-3 (continued)

A GREEN PUSH WITH CONTROL SYSTEM OPERATING

Ford Motor Company
Rouge Plant - Coke Battery
Dearborn, Michigan



36-6



37-6